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and MEDICAL PROGRAM ADVISORS

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PROCEEDINGS

of the

ANNUAL CONFERENCE OF NASA CLINIC DIRECTORS, ENVIRONMENTAL HEALTH OFFICIALS, AND MEDICAL PROGRAM ADVISORS

held at

SHERATON-FORT SUMTER HOTEL
CHARLESTON, SOUTH CAROLINA

OCTOBER 12, 13, AND 14, 1971

PREFACE

I am pleased to have published these papers which were presented at the NASA Occupational Medicine and Environmental Health Annual Conference in Charleston, South Carolina, on October 12, 13, and 14, 1971.

The interchange of information, data, and techniques discussed at the meeting does much to enhance the quality of medical care for NASA personnel and assists in maintaining the high level program of medicine which is a part of NASA's standard.

Appreciation is expressed not only to each participant associated with the National Aeronautics and Space Administration but also to the visiting authorities from other organizations, all of whose efforts made the conference successful.

Louis B. Arnoldi, M.D.
Director, Division of Occupational
Medicine and Environmental Health

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THE MANAGEMENT OF NASA EMPLOYEE HEALTH PROBLEMS

Status 1971

by

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and Environmental Health
NASA Headquarters

As we review the past year of employee health with NASA, a population, now, of 30,000 workers, located at ten major installations throughout the country, and a far greater number of smaller stations and offices throughout the world, we find that the estimated annual cost of major illness, injury, disability, and death exceeds 4.7 million dollars, and that no estimate of resources lost because of minor illness episodes, machinery or facilities damaged because of human errors, or lowered productivity, perhaps due to health problems, is possible.

Major illness episodes affect an estimated 7 percent of the population per year, or 2,200 workers. Two hundred of these are permanently separated from NASA either through death or disability retirement. While we have no accurate measure of minor episodes, over 66,000 illness and injury first treatments and 48,000 additional or follow up treatments were administered by NASA medical facilities in 1970.

The current annual level of expenditure for occupational medicine and environmental health is 4.6 million dollars, a budget which provides equipment and supplies, and the salaries of 298 technical and administrative employees. These resources are distributed primarily on the basis of availability, with little regard to, or knowledge of, the problems which they are expected to solve.

At NASA, a recent emphasis has been placed on the assessment of employee health problems and the development of specific methods and programs which would attempt their resolution. The essential key, here, as in all fields of scientific endeavor, lies in information. With information we can isolate and define our problem and measure its significance. With information we can plan our attack, monitor our progress, and adjust our program to best accomplish our objectives. And finally, with information, we can judge our success or failure.

In the past year there have been some significant advances in information techniques within our NASA health programs. Michoud has developed an automated billing system for medical services, based on an input format designed by the Kennedy Space Center (Figures 1 and 2). This system now provides information on the cost of medical services by service user and will measure in dollars that portion of resources spent on preventive techniques versus therapeutic techniques. With only a slight modification, the same system can provide important cost data by age, sex, and occupational groups, and even by disease categories, and by so doing, can supply important management guidance in medical resources allocations.

Marshall, applying a concept used by Langley and Lewis since 1959, to their medical data file, has developed a report which can accumulate and print instantaneously a ten year examination history on an employee, in a matrix which far surpasses the capacity and efficiency of the traditional medical file (Figures 3 to 6). With this summary, and a

CRT terminal, a physician can rapidly scan volumes of medical records and select candidates for examination based on clinical priorities, rather than arbitrary age or grade limits.

A system funded by Headquarters combines inputs from four major NASA installations, and permits us to measure health trends in different populations (Figures 7 to 10). With data supplied by the Kennedy Space Center, we now have our first indication of health problems among our contractor employees.

The first experimentation with a self-administered automated history was conducted at Goddard this summer. In the next year, with the cooperation of the Tennessee Valley Authority, they will begin electrocardiograph screening by computer, and if it proves successful, will develop their own in-house capability.

The Manned Spacecraft Center, using concepts originally developed for the astronaut program, currently has computerized validation of their laboratory activities, and in 1972 plans to expand their data file to cover health records on all of their employees.

Marshall's data base goes back four years, to early 1968. Wallops Station is programming one which will include 13 years of annual records, back to the beginning of NASA, and perhaps even to their original establishment under NACA.

In a recent assessment of NASA-wide mortality records over the past five years, age adjusted death rates among both professional

and non-professional workers were found to be significantly higher at the manned space flight centers than at the research centers, suggesting that differences in the occupational environment may exist, and may have an adverse effect on employee health. In May of this year, the Lewis Research Center screened over 3,000 of its total population for obesity, hypertension, and blood chemistry abnormalities. As these data are analyzed, it will be possible to compare them with similar data from the Marshall file and perhaps they will provide some clues to the differences in the evolution of chronic disease.

The systems and reports discussed here are only a few of an enormous quantity of information now available to us. None have been developed without the shared ideas and combined imputs of all of the individual NASA medical and environmental health teams. In the future, with the advent of real-time information capability, with terminals and computer lines dedicated to medical use, with shared data bases, it will be possible to isolate health problems throughout NASA and to identify the elusive populations at risk. With a single telephone call, a researcher at one installation, testing for differences and prevalances in his population, will be able to obtain information on rates at other NASA installations, and a medical officer or environmental health engineer detecting an unusual condition or high incidence in an isolated small population, by tapping the resources of the larger combined file, can verify his finding.

These are some of the uses for which NASA medical information systems are being created. As they expand and grow, it is hoped that they will serve not only as an aide in our own problem solving, but also as a demonstration for other organizations.

ORGANIZATION- BOEING

WEEK ENDING 6/18/71

	WEEKLY TOTAL	MONTHLY ACUM TOTAL	YEAR TO DATE TOTAL	WEEKLY DOLLARS	MONTHLY ACUM DOLLARS	YEAR TO DATE DOLLARS
EXAMINATIONS						
PRE-EMPLOYMENT	00000	00000	00000	0.00	0.00	0.00
SEPARATION	00000	00000	00000	0.00	0.00	0.00
RETURN TO WORK	00000	00000	00000	0.00	0.00	0.00
HEALTH MAINTENANCE						
MISCELLANEOUS	00000	00000	00000	0.00	0.00	0.00
EXECUTIVE	00000	00000	00000	0.00	0.00	0.00
SUPERVISOR	00000	00000	00000	0.00	0.00	0.00
PERIODIC	00000	00000	00000	0.00	0.00	0.00
PRELIMINARY	00000	00000	00000	0.00	0.00	0.00
JOB RELATED						
MISCELLANEOUS	00000	00000	00000	0.00	0.00	0.00
CERTIFICATION	00000	00000	00000	0.00	0.00	0.00
FOOD SERVICE	00000	00000	00000	0.00	0.00	0.00
DRIVERS	00000	00000	00000	0.00	0.00	0.00
HAZARDOUS DUTY	00000	00000	00000	0.00	0.00	0.00
HIGH NOISE EXPOSURE	00000	00000	00000	0.00	0.00	0.00
WHITE ROOM	00000	00000	00000	0.00	0.00	0.00
FITNESS FOR DUTY	00000	00000	00000	0.00	0.00	0.00
RADIATION	00000	00000	00000	0.00	0.00	0.00
OTHER						
MISCELLANEOUS	00000	00000	00000	0.00	0.00	0.00
CARDIAC EVALUATION	00000	00000	00000	0.00	0.00	0.00
REVIEW OF RECORDS	00000	00000	00000	0.00	0.00	0.00

Figure 1

02"

MASON-RUST MEDICAL STATISTICAL REPORT

ORGANIZATION- BOEING

WEEK ENDING 6/19/71

	WEEKLY TOTAL	MONTHLY ACUM TOTAL	YEAR TO DATE TOTAL	WEEKLY DOLLARS	MONTHLY ACUM DOLLARS	YEAR TO DATE DOLLARS
HEALTH COUNSELING AND ED.	00000	00000	00000	0.00	0.00	0.00
IMMUNIZATIONS						
TETANUS & DIPTHERIA	00000	00000	00000	0.00	0.00	0.00
SMALLPOX	00000	00000	00000	0.00	0.00	0.00
INFLUENZA	00000	00000	00000	0.00	0.00	0.00
OTHER	00000	00000	00000	0.00	0.00	0.00
INITIAL TREATMENTS						
OCC. DISEASE	00000	00000	00000	0.00	0.00	0.00
OCC. INJURY	00000	00000	00000	0.00	0.00	0.00
NON-OCC. DISEASE	00000	00000	00000	0.00	0.00	0.00
NON-OCC. INJURY	00000	00000	00000	0.00	0.00	0.00
REVISIT TREATMENTS						
OCC. DISEASE	00000	00000	00000	0.00	0.00	0.00
OCC. INJURY	00000	00000	00000	0.00	0.00	0.00
NON-OCC. DISEASE	00000	00000	00000	0.00	0.00	0.00
NON-OCC. INJURY	00000	00000	00000	0.00	0.00	0.00
PRESC. BY PRIV. PHYS.	00000	00000	00000	0.00	0.00	0.00
PATIENT COUNT	00000	00000	00000	0.00	0.00	0.00

Figure 2

NASA/MSFC MEDICAL AUTOMATION SYSTEM - PATIENT SUMMARY REPORT

HISTORY DATA

1991 : PATIENT MEDICAL NUMBER

EMPLOYEE DATA

SEX	: M		
BIRTH DATE MO/DA/YR	: 62113		
PERFORMING ACTIVITY	: 276		
OCCUPATION CODE	: 7010		
NASA CLASS CODE	: 00000		
GS/WB LEVEL	: 0515		

PRESENT MEDICATIONS (1:YES 0:NO) FOR

BLOOD PRESSURE	: 1		
ANTI-ANGINAL	: 0		
DIABETES	: 0		
ARTHRITIS	: 0		
HORMONES	: 0		
TRANQUILIZERS	: 0		
OTHER	: 0		

EMPLOYEE STATUS

STATUS CODE	: U		
SEPARATION CODE	: 0		
SEPARATION DATE	: 0		
REASON FOR SEPARATION IF DUE TO HEALTH			
DIAGNOSIS CODE	: .0		
DIAGNOSIS CODE	: .0		
DIAGNOSIS CODE	: .0		

SMOKING HABIT (1:YES 2:NO)

EVER SMOKED PIPE OR CIGAR	: 1		
EVER SMOKED CIGARETTES	: 1		
YEARS SMOKED	: 25		
PRESENTLY SMOKING CIGARETTES	: 2		
AVG CIGARETTES A DAY	: 0		

PREVIOUS MEDICAL CONDITIONS RELATING TO

DENIAL OF LIFE INSURANCE	DIAGNOSIS CODE/DATE :	0.
OPERATIONS	DIAGNOSIS CODE/DATE :	0.
HOSPITALIZATION	DIAGNOSIS CODE/DATE :	0.
OTHER INJURY OR ILLNESS	DIAGNOSIS CODE/DATE :	0.
TREATMENT WITHIN PAST 5 YEARS	DIAGNOSIS CODE/DATE :	0.
REJECTION FOR MILITARY SERVICE	DIAGNOSIS CODE/DATE :	0.
MILITARY DISCHARGE BECAUSE OF HEALTH	DIAGNOSIS CODE/DATE :	0.

Figure 3

NASA/MSFC MEDICAL AUTOMATION SYSTEM - PATIENT SUMMARY REPORT

PHYSICAL EXAM DATA CONTINUED

1991 : PATIENT MEDICAL NUMBER	EXAM 1	EXAM 2	EXAM 3	EXAM 4	EXAM 5	EXAM 6	EXAM 7	EXAM 8	EXAM 9	EXAM 10
GENERAL CHARACTERISTICS (0=NORMAL 1=ABNORMAL 2=NOT EXAMINED)										
GENERAL APPEARANCE	0	0	0	0						
POSTURE	0	0	0	0						
GAIT	0	0	0	0						
BEHAVIOR	0	0	0	0						
HEAD	0	0	0	0						
EYES	0	0	0	0						
FUNDI	0	0	0	0						
EARS	0	0	0	0						
NMT	0	0	0	0						
NECK	0	0	0	0						
UPPER EXTREMITY	0	0	0	0						
THORAX	0	0	0	0						
BREASTS	0	0	0	0						
LUNGS	0	0	0	0						
HEART	0	0	0	0						
ABDOMEN	0	0	0	0						
GROIN-GENITALIA	0	0	0	0						
BACK	0	0	1	0						
PELVIS	0	0	0	0						
RECTUM-ANUS	0	0	0	0						
PROSTATE	0	0	1	0						
FEMALE PELVIS	2	2	2	2						
LOWER EXTREMITY	0	0	0	0						
ARTERIES AND VEINS	0	0	0	0						
JOINTS	0	0	0	0						
MUSCLES	0	0	0	0						
NEUROLOGICAL	1	1	0	0						
SKIN	0	0	0	0						
LYMPH NODES	0	0	0	0						
OTHER	0	0	0	0						
X-RAYS (1=NORMAL 2=SUSPICIOUS 3=ABNORMAL)										
CHEST X-RAY	0	1	1	1						
BACK X-RAY	0	0	0	0						
KUB X-RAY	0	0	0	0						
OTHER X-RAY	0	0	0	0						

Figure 4

NASA/MSFC MEDICAL AUTOMATION SYSTEM - PATIENT SUMMARY REPORT

PHYSICAL EXAM DATA

1991 : PATIENT MEDICAL NUMBER	EXAM 1	EXAM 2	EXAM 3	EXAM 4	EXAM 5	EXAM 6	EXAM 7	EXAM 8	EXAM 9	EXAM 10
EXAM DATE YR/MO/DA :	680404	690326	700417	710614						
EXAM TYPE (1=PREPLAC 2=RE-EMP 3=PERIODIC 6=EXEC 7=MONITOR):	3	3	3	6						
WORK CLASSIFICATION :	0	1	2	1						
EXAMINING PHYSICIAN :	0	0	0	6						
PHYSICAL CHARACTERISTICS										
HEIGHT :	5-10	5-10	5-10	5-10						
WEIGHT :	183.	180.	179.	173.						
IDEAL WEIGHT :	0.	0.	0.	153.						
PULSE :	104.	80.	88.	96.						
SYSTOLIC BLOOD PRESSURE :	150.	124.	126.	128.						
DIASTOLIC BLOOD PRESSURE :	96.	80.	74.	86.						
RECUMBENT SYS BLOOD PRESS :	0.	0.	0.	0.						
RECUMBENT DIA BLOOD PRESS :	0.	0.	0.	0.						
ARM SKIN FOLDS :	0.	0.	0.	18.						
BACK SKIN FOLDS :	0.	0.	0.	22.						
VISION										
COLOR VISION :										
FAR SIGHT R EYE UNAIDED :	0.	0.	0.	100.						
FAR SIGHT R EYE CORRECTED :	20.	20.	20.	20.						
FAR SIGHT L EYE UNAIDED :	0.	0.	0.	0.						
FAR SIGHT L EYE CORRECTED :	30.	20.	30.	20.						
NEAR SIGHT R EYE UNAIDED :	0.	0.	0.	100.						
NEAR SIGHT R EYE CORRECTED :	20.	20.	20.	20.						
NEAR SIGHT L EYE UNAIDED :	0.	0.	0.	0.						
NEAR SIGHT L EYE CORRECTED :	20.	20.	20.	20.						
PROCTOSCOPIC (1=NEG 2=BENIGN POLYP 3=CANCER 4=OTHER) :	0	0	0	0						
DIAGNOSIS (STATUS CODE=1 NEW DIAGNOSIS CODE=0 SAME DIAGNOSIS)										
DIAGNOSIS CODE 1 :	401.0	401.0	401.0	401.0						
STATUS CODE 1 :	0.	0.	0.	0.						
DIAGNOSIS CODE 2 :	.0	781.3	112.0	600.0						
STATUS CODE 2 :	0.	0.	0.	0.						
DIAGNOSIS CODE 3 :	.0	358.*	660.0	991.3						
STATUS CODE 3 :	0.	0.	0.	0.						
DIAGNOSIS CODE 4 :	.0	.0	725.1	711.3						
STATUS CODE 4 :	0.	0.	0.	1.						
DIAGNOSIS CODE 5 :	.0	.0	991.*	.0						
STATUS CODE 5 :	0.	0.	0.	0.						

Figure 5

NASA/MSFC MEDICAL AUTOMATION SYSTEM - PATIENT SUMMARY REPORT

LABORATORY DATA

1991 : PATIENT MEDICAL NUMBER	EXAM 1	EXAM 2	EXAM 3	EXAM 4	EXAM 5	EXAM 6	EXAM 7	EXAM 8	EXAM 9	EXAM 10
LABORATORY DATE YR/MO/DA :	680402	690319	700416	710607						
HEMATOCRIT :	47.	49.	52.	48.						
PLATELETS :	N	N	N	N						
WHITE BLOOD COUNT :	69.	83.	78.	79.						
GLUCOSE FASTING :	79.	96.	70.	89.						
GLUCOSE TWO HOUR :	0.	0.	0.	0.						
CHOLESTEROL :	230.	205.	202.	229.						
URIC ACID :	4.6	5.9	5.6	5.7						
SGPT :	14.	31.	27.	15.						
THYMOL TURBIDITY :	0.	0.	0.	0.						
BILIRUBIN DIRECT :	0.	0.	0.	0.						
BILIRUBIN INDIRECT :	0.	6.	8.	0.						
BILIRUBIN TOTAL :	6.	6.	8.	2.						
URINALYSIS										
RED CELLS :	0.	0.	0.	0.						
WHITE CELLS :	0.	0.	0.	2.						
SPECIFIC GRAVITY :	.000	1.019	1.015	1.014						
SUGAR :	0.	0.	0.	0.						
ALBUMIN :	0.	0.	0.	0.						
PH :	0.	6.	7.	8.						
CHEST X-RAY										
THORACIC DIAMETER :	0.	0.	0.	130.						
TOTAL HEART DIAMETER :	0.	0.	0.	300.						
HEART SIZE :	0.	0.	0.	1.						
AORTA :	0.	0.	0.	1.						
PARENCHYMAL :	0.	0.	0.	4.						
ELECTROCARDIOGRAM										
HEART RATE :	80.	80.	80.	77.						
P-R INTERVAL :	0.	0.	0.	19.						
QRS COMPLEX :	0.	0.	0.	7.						
QRS AXIS :	0.	5.	30.	1.						
NORMAL/ABNORMAL :				N						
ABNORMAL CONDITIONS										
Q-WAVE :	0.	0.	0.	0.						
R-WAVE :	0.	0.	0.	0.						
S-T SEGMENT :	0.	0.	0.	0.						
T-WAVE :	0.	0.	0.	0.						
A-V CONDITION :	0.	0.	0.	0.						
VENTRIC CONDITION :	0.	0.	0.	0.						
ARRHYTHMIAS :	0.	0.	0.	0.						
MISCELLANEOUS :	0.	0.	0.	0.						
PULMONARY FUNCTION										
VITAL CAPACITY :	0.	0.	0.	40.						
FORCED EXPIRATION VOLUME :	0.	0.	0.	27.						

Figure 6

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OCCURRENCE OF FIRST VISIT DIAGNOSES BY ORGANIZATION AND AGE
(DIAGNOSES POOLED BY PRIMARY ICD SYSTEM CLASSIFICATION)
GODDARD SPACE FLIGHT CENTER
NASA EMPLOYEES

ICD DIAGNOSIS CLASSIFICATION	**** 17-24	25-29	30-34	-- 35-39	AGE 40-44	-- 45-49	50-54	55-59	**** 60 +	TOTAL	POPULATION TOTAL	PERCENTAGE
260 PROGRAM SUPPORT					1					1	132	.0075
270 STADAN ENGINEERING									1	1	93	.0107
820 MANNED FLIGHT OPERATIONS							1			1	187	.0053
MENTAL DISORDERS												
210 FINANCIAL MANAGEMENT					1					1	82	.0121
220 MANPOWER UTILIZATION	1				1					2	68	.0294
230 MANAGEMENT SERVICES & SUPPLY					1					1	143	.0069
250 TECHNICAL INFORMATION					1					1	97	.0103
280 EXPERIMENTAL FABRICATION					1	1		1		3	139	.0215
290 PLANT OPERATION & MAINTENANCE					1	1				2	170	.0117
310 QUALITY ASSURANCE	1									1	68	.0147
320 TEST AND EVALUATION				1		2	1			4	214	.0186
440 OSO									1	1	24	.0416
450 NIMBUS						1				1	29	.0344
460 ATS				1						1	31	.0322
510 PROJECT OPERATIONS				2		1				3	73	.0410
530 STADAN OPERATIONS							1			1	98	.0102
550 MISSION & TRAJECTORY ANALYSIS				1						1	79	.0126
560 INFORMATION PROCESSING						1				1	153	.0065
640 LAB FOR THEORETICAL SCIENCES				1			1			2	101	.0198
720 SPACECRAFT INTEGRATION		1								1	436	.0022
730 SYSTEMS		1		1	1					3	236	.0127
820 MANNED FLIGHT OPERATIONS			1	1						2	187	.0106
840 NASA COMMUNICATIONS					2					2	80	.0250
DISEASES OF THE NERVOUS SYSTEM AND SENSE ORGANS												
100 OFFICE OF THE DIRECTOR						1				1	15	.0666
200 ADMINISTRATION & MANAGEMENT				1	1			1		3	76	.0394
210 FINANCIAL MANAGEMENT						2				2	82	.0243
220 MANPOWER UTILIZATION	3				2	3				8	68	.1176
230 MANAGEMENT SERVICES & SUPPLY	1		1	2	2			1		7	143	.0489

Figure 7

REPORT 05 ANNUAL 1971

OCCURRENCE OF FIRST VISIT DIAGNOSES BY ORGANIZATION AND AGE (DIAGNOSES POOLED BY PRIMARY ICD SYSTEM CLASSIFICATION) GODDARD SPACE FLIGHT CENTER NASA EMPLOYEES

ICD DIAGNOSIS CLASSIFICATION	AGE 17-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60 +	TOTAL	POPULATION TOTAL	PERCENTAGE
840 NASA COMMUNICATIONS	1		1					1		3	80	.0375
DISEASES OF THE CIRCULATORY SYSTEM												
200 ADMINISTRATION & MANAGEMENT					3	2	1	1		7	76	.0921
210 FINANCIAL MANAGEMENT							1	2		3	82	.0365
220 MANPOWER UTILIZATION						1				1	68	.0147
230 MANAGEMENT SERVICES & SUPPLY	2				4		4	3	1	14	143	.0979
240 PROCUREMENT					1	1		1		3	242	.0123
250 TECHNICAL INFORMATION					2					2	97	.0206
260 PROGRAM SUPPORT					1		4			5	132	.0378
270 FACILITIES ENGINEERING					1		1			2	35	.0571
280 EXPERIMENTAL FABRICATION				1	1	2	7	2	2	15	139	.1079
290 PLANT OPERATION & MAINTENANCE						3	6	2	2	13	170	.0764
300 SYSTEMS RELIABILITY							1			1	11	.0909
310 QUALITY ASSURANCE	1	2			1					4	68	.0588
320 TEST AND EVALUATION					1		1			2	214	.0093
400 PROJECTS							1			1	9	.1111
410 OAO				1						1	33	.0303
430 ERTS							1			1	15	.0666
440 OSO									1	1	24	.0416
450 NIMBUS						1				1	29	.0344
460 ATS				1			2			3	31	.0967
470 DELTA					1			1		2	34	.0588
500 TRACKING & DATA SYSTEMS					1					1	34	.0294
510 PROJECT OPERATIONS					1					1	73	.0136
520 ADVANCED DEVELOPMENT				2	2		1			5	113	.0442
540 COMPUTATION	1					1				2	83	.0240
550 MISSION & TRAJECTORY ANALYSIS				2	1	2	1			6	79	.0759
560 INFORMATION PROCESSING			1	1	2	1	1			6	153	.0392
570 STADAN ENGINEERING						1				1	93	.0107
610 LABORATORY FOR SPACE SCIENCES					2			1		3	335	.0089
620 LAB FOR ATMOSPHERIC & BIO SCIENCES					1					1	148	.0067
640 LAB FOR THEORETICAL SCIENCES			2		3	1	3	1		10	101	.0990

Figure 8

REPORT 05 ANNUAL 1971

OCCURRENCE OF FIRST VISIT DIAGNOSES BY ORGANIZATION AND AGE
(DIAGNOSES POOLED BY PRIMARY ICD SYSTEM CLASSIFICATION)
KENNEDY SPACE CENTER
CONTRACTOR EMPLOYEES

ICD DIAGNOSIS CLASSIFICATION	**** 17-24	25-29	30-34	-- AGE -- 35-39	40-44	45-49	50-54	55-59	**** 60 +	TOTAL	POPULATION TOTAL	PERCENTAGE
MENTAL DISORDERS												
025 TWA		2	1	1	1					5	2384	.0020
028 BENDIX					3					3	1694	.0017
088 FEC				1	3					4	1355	.0029
141 PAN AMERICAN		1				1				2	251	.0079
OTHER	1					1	1			3		
DISEASES OF THE NERVOUS SYSTEM AND SENSE ORGANS												
001 NASA/KSC					1					1	2733	.0003
025 TWA	2	6	5	9	2	5	1	5		35	2384	.0146
028 BENDIX		2	4	1	1	1	1		1	11	1694	.0064
029 BOEING			1	3	1	1	1			7	1071	.0065
030 MCDONNEL DOUGLAS		2			1	2				5	788	.0063
033 GRUMMAN				3		1		1		5	713	.0070
034 IBM		1								1	403	.0024
039 NORTH AMERICAN				1		1		1		3	996	.0030
088 FEC	1	2	1	4	1	2	1			12	1355	.0088
119 LING-TEMCO-VOUGHT (STC)	2									2	306	.0065
141 PAN AMERICAN	2		1							3	251	.0119
OTHER		1	4	3	3			1		12		
DISEASES OF THE CIRCULATORY SYSTEM												
001 NASA/KSC				2		1	2		2	7	2733	.0025
025 TWA	8	18	12	14	8	16	10	6	1	93	2384	.0390
028 BENDIX	7	17	33	12	22	21	12	1	6	131	1694	.0773
029 BOEING		10	16	26	35	40	21	5		153	1071	.1428
030 MCDONNEL DOUGLAS		1	1		5	1	1			9	788	.0114
033 GRUMMAN	3	6	8	11	21	1	3	2	4	59	713	.0827
034 IBM	1	4	7	2	2	4	2			22	403	.0545
039 NORTH AMERICAN		10	10	16	16	15	7	2		76	996	.0763

Figure 9

REPORT 05 ANNUAL 1971

OCCURRENCE OF FIRST VISIT DIAGNOSES BY ORGANIZATION AND AGE
(DIAGNOSES POOLED BY PRIMARY ICD SYSTEM CLASSIFICATION)
KENNEDY SPACE CENTER
CONTRACTOR EMPLOYEES

ICD DIAGNOSIS CLASSIFICATION	**** 17-24	25-29	30-34	-- 35-39	AGE 40-44	-- 45-49	50-54	55-59	**** 60 +	TOTAL	POPULATION TOTAL	PERCENTAGE
040 RCA			1							1	495	.0020
060 CHRYSLER			5	5		3	3		2	18	231	.0779
088 FEC	17	9	6	9	7	3	3	6		60	1355	.0442
098 GENERAL ELECTRIC		5	3	4	6	3	1			22	225	.0977
119 LING-TEMCO-VOUGHT (STC)					1		2			3	306	.0098
141 PAN AMERICAN	6	6	5	12	12	10	7	2		60	251	.2390
OTHER	11	12	10	15	11	15	14	6	6	100		
DISEASES OF THE RESPIRATORY SYSTEM												
001 NASA/KSC	1		1	2	2					6	2733	.0021
025 TWA	44	68	54	50	34	43	27	11	5	336	2384	.1409
028 BENDIX	4	26	25	14	23	31	11	8	2	144	1694	.0850
029 BOEING		5	3	7	7	9	10	1		42	1071	.0392
030 MCDONNEL DOUGLAS	1		4	1	7	2	2	3		20	788	.0253
033 GRUMMAN	2	5	7	8	4	2	4			32	713	.0448
034 IBM		1	1	2	2	1				7	403	.0173
039 NORTH AMERICAN	4	7	13	11	10	3	3	2		53	996	.0532
068 CHRYSLER		2		4		1	3			10	231	.0432
088 FEC	15	37	17	11	13	4	2	2	1	102	1355	.0752
098 GENERAL ELECTRIC		1		5	2		1			9	225	.0400
119 LING-TEMCO-VOUGHT (STC)	1	1	1	2	1					6	306	.0196
141 PAN AMERICAN	1	2	3	1	1	3				11	251	.0438
OTHER	26	33	24	19	24	19	7	4	4	160		
DISEASES OF THE DIGESTIVE SYSTEM												
025 TWA	6	10	6	2	5	2	3			34	2384	.0142
028 BENDIX			2	1	1	1	1	3		9	1694	.0053
029 BOEING	1			1		2				4	1071	.0037
030 MCDONNEL DOUGLAS						1				1	788	.0012
033 GRUMMAN		1				1				2	713	.0028
039 NORTH AMERICAN		1	1	1	1		1			5	996	.0050
088 FEC	2	1	2	3	2		1			11	1355	.0081

Figure 10

N 73-17080

CORONARY RISK FACTOR SCORING AS A GUIDE FOR COUNSELING

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NASA Headquarters Health Unit

CORONARY RISK FACTOR SCORING AS A GUIDE FOR COUNSELING

by Robert L. Fleck, M.D.
NASA Headquarters Health Unit

The prominence of coronary heart disease as a major cause for the loss to industry of personnel in their prime has been acknowledged for years. Since effective prevention must precede the actual development of even covert disease it is necessary to identify those factors known to be associated with greater incidence of the disease and from there take corrective action where possible. An effort has been made at NASA HQ to evolve a scoring system from data available in a regular periodic health examination that would result in a number that could be analyzed statistically and yet have practical clinical significance. Figure number 1 shows the system in current use which is the result of influence from review of the literature in general and in particular from the December, 1964 issue if 'The Annals of Internal Medicine'. This issue contained several articles evaluating the results of periodic health examinations of ten major industries. Many tables were presented but the list shown was selected from a tabulation of subjects dying of coronary heart disease that had not been previously suspected or diagnosed with the order of frequency of occurrence for each item being retained. The weighting factor has since been added in an effort to give greater clinical significance to the resulting number with the significant level being set at 5 or more since the average score of those dying of the disease was between 5 and 6. Referring to the chart it is readily apparent that the weighting is entirely arbitrary. To describe the many interacting factors and influences which led to the present form would be far too time consuming. The essential feature, however, is to record progressively higher scores for those items known to involve higher risks the further from normal they are. One possible improvement would be to score two points for an

uncontrolled hypertensive state and one point if controlled on the assumption that a subject requiring treatment to control his pressure would have a bit higher risk than one not requiring treatment at all. In spite of the arbitrary nature of the scoring and the obvious omissions and imperfections it does appear that this system is indeed successful in identifying the high risk subjects.

Using the sample of subjects identified last year consisting of those employees who had three or more complete physical examinations including the dynamic EKG study and at least one year between each examination, the following correlations were made: of the 362 subjects, Figure number 2 shows that there were 44 subjects with a score of 5 or more on their last examination of which 5 had already experienced symptomatic coronary heart disease while of the 67 with scores of 1 or less 1 had such a previous diagnosis made. Further, of the 251 subjects between the 1 and 5 level, 3 have had previous coronary episodes which is very close to the low risk group percentage.

A look at the correlations of dynamic EKG results according to risk factor groups shows this procedure to be a possible prediction aid as well as an early detection device. A review of the data identified on dynamic studies is shown in Figure number 3. Note that many items with code numbers are not considered to have any clinical significance such as sinus arrhythmia, wandering pacemaker, and supraventricular premature contractions while other findings are of uncertain significance such as transient T wave inversions or notched T waves. Figure number 4 shows that the overall ratio is about 2 to 1 with the high risk group having the higher incidence of other than normal

findings. If the findings considered to have no clinical significance are removed, the ratio indicates that the high risk group is four times as likely to have an abnormal dynamic EKG than the low risk group.

An itemized breakdown is shown in Figure number 5 which shows that practically every item is more prominent in the high risk group except for the completely normal column. Of interest is the consistent finding of the higher incidence of the high risk groups in many categories not considered to be a part of coronary heart disease EKG patterns at rest or with exercise. The validity of this is of course far from established. Thus it does seem that this scoring technique has proven to be effective in identifying those subjects at high risk for coronary heart disease. To relook at the list (Figure number 1) it is noted that many items are non-action in nature. Effective prevention must be considered multifactoral so any discussion of any single item does not imply that others are neglected although it is admitted that the cholesterol problem seems to be ever with us. It must be admitted that to date there is no positive proof that cholesterol reduction reduces one's risk. It may also be noted that there is no positive proof to the contrary. Since our first three coronary episodes at NASA HQ this year involved subjects with cholesterols over 400 on their last physical examination, perhaps we should more promptly recommend therapeutic agents in addition to diet. Indeed, perhaps antihypertensive measures should be initiated at much lower levels than the old diastolic pressure of 100 used for so many years and still used by many clinicians. There are however, other considerations

that should at least postpone discouragement in our ability to prevent even though it does seem we are much more effective in the prediction than in prevention. Consider that this program has been developing at NASA HQ for the past six years in an attempt to cope with a process that spans 20 to 30 years or even longer in its overall progress. It is very logical to consider the lead time is responsible for many failures at preventive efforts. Also, the occasions of failure are so immediately obvious whereas our successes have yet to be proven. It could be that effective action must be made while a person is in his late 20's or 30's or indeed that the best we can do is to so influence the current generation that they will influence their children and perhaps the next generation after that before a reduction of the incidence of coronary heart disease will achieve statistical significance. The fact that the incidence of significant coronary atherosclerosis found in young Korean conflict casualties in the early 50's is present to the same degree in Vietnam today would indicate that effective preventive efforts must be initiated at an early age indeed. Rather than adopt a pessimistic attitude, however, it does seem logical that the reduction of one's risk factor score would at least arrest or slow down a progressive atherosclerotic process.

To test the possible improvement in both detection and counseling of employees having abnormal lipid metabolism a phenotype classification was obtained on 65 subjects at NASA HQ and on an additional group from Goddard. The test measured cholesterol, triglycerides, total lipid and total phospholipid levels and the electrophoretic pattern, and was performed by a local independent laboratory. Figure number 6 shows the results which is admittedly biased in favor of group II and against group IV phenotypes since only those

subjects having a cholesterol level of 300 or better on one or more of the three documented examinations were selected for this study. Since a type IV hyperlipidemia may have a normal or slightly elevated cholesterol level many subjects may be missed entirely where only the cholesterol test is employed. This not only effects the success of a detection effort but also the value of counseling given. The addition of the triglyceride test to the chemistries obtained on routine periodic health examinations would correct this defect. The remainder of the profile testing is not considered to contribute enough additional information to justify the extra expense.

In summary, it does appear that a risk factor scoring system may be effective in identifying subjects who are in a high risk category for coronary heart disease. It also appears that the ability to predict exceeds our ability to prevent coronary heart disease or its complications to date. Although prevention may well have to be applied at a very early age to be effective it is essential that both predictive and preventive efforts continue now so that knowledge gained may further improve both efforts as well as to benefit employees' survival and rehabilitation potential. The addition of the triglyceride test to the routine procedures would be one important step in this direction.

WEIGHTED SCORING SYSTEM FOR CORONARY RISK FACTORS

1. CHOLESTEROL: Score one point for each 50 mgm. over 200 (200-249 = 1, 250-299 = 2, 300-349 = 3, etc...).
2. FAMILY HISTORY: Score two if any immediate member of family has a bonafide history of coronary heart disease. Immediate member refers to parents or brothers or sisters. Do not score if precise knowledge is not known.
3. SMOKING: Score one for each pack of cigarettes per day. (.5 for 1/2 pack). If pipe or cigar smoker claims he inhales attempt a realistic equivalent score (such as .5 point for each cigar or pipeful inhaled).
4. WEIGHT: Using the Metropolitan Life Insurance tables (note height and maximum weight is with indoor clothing and shoes) and score one point if 20% over maximum weight listed plus an additional point for each 10% over this point.
5. HYPERTENSION: Score one point if systolic pressure is 150 or better in either arm or diastolic pressure is 94 or better in either arm. (If on treatment for hypertension but BP is under above, do not score.
6. ABNORMAL ECG: Score one point if ECG is not normal. (Score even if finding not considered to be clinically significant).
7. WHITE BLOOD COUNT: Score .5 point if total WBC is 12,000 or better. (Score even if cause is known to be transient).
8. ERYTHROCYTE SEDIMENTATION RATE: Score .5 if 18 mm/hr or higher.
9. FASTING BLOOD SUGAR: Score .5 if FBS over 100 (101 or higher) or if history of diabetes mellitus is present irrespective of treatment.
10. URIC ACID: Score .5 point if uric acid is 6.9 mgm% or higher or if bonafide history of gout is present.

FIGURE 1

Percentages of the Total Population (Base Line) and of High and Low Risk Subpopulations Manifesting Coronary Heart Disease

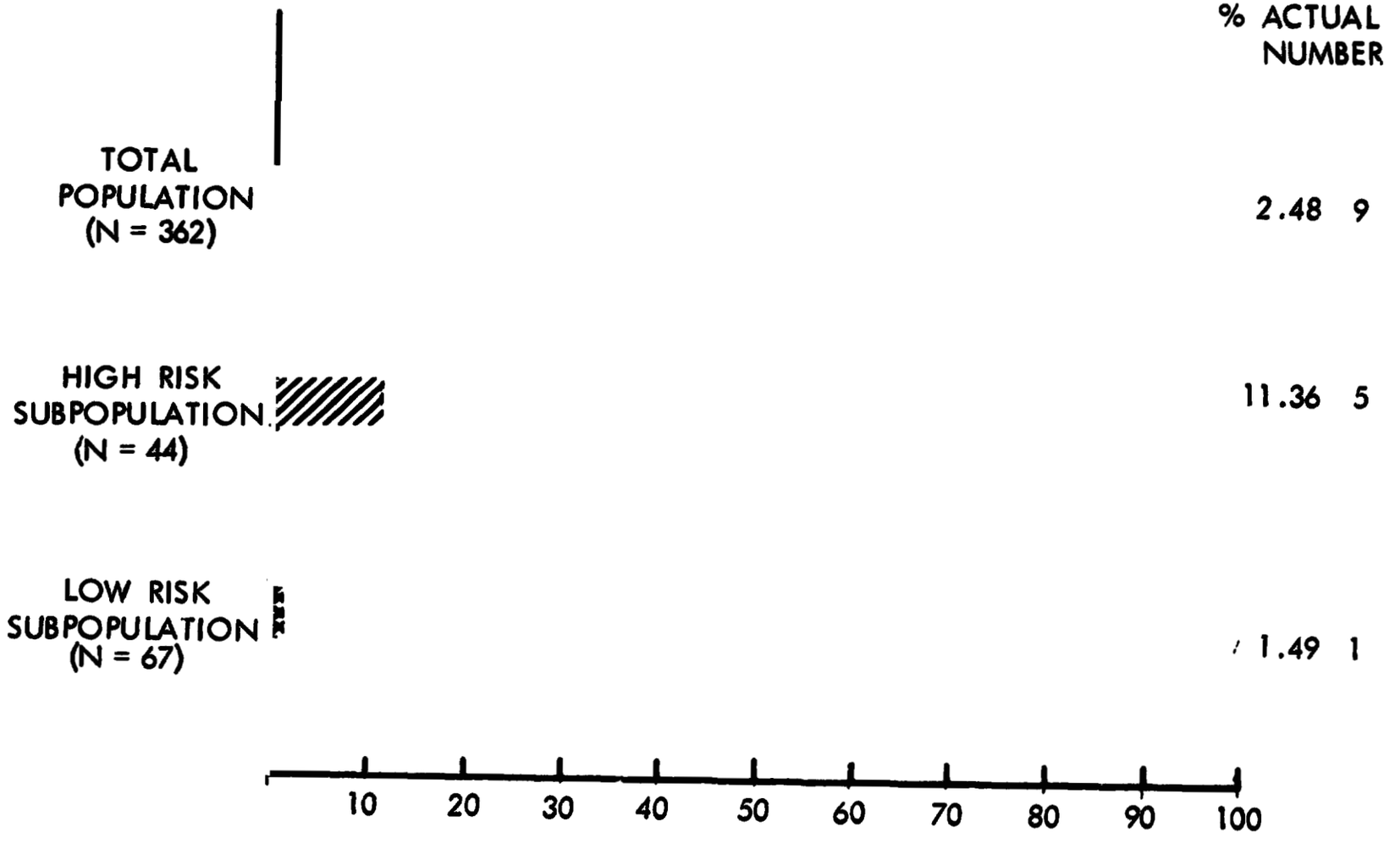

FIGURE 2

DYNAMIC EKG CODING SYSTEM

NUMBER	FINDING
00	NO ABNORMALITIES
00-99	RHYTHM
01	TACHYCARDIA, SINUS, PERSISTANT (no rate under 90 BPM)
02	TACHYCARDIA, PAROXYSMAL
02.1	ATRIAL
02.2	NODAL
02.3	VENTRICULAR
03	ATRIAL FIBRILLATION
03.1	PERSISTANT
03.2	INTERMITTENT
04	ATRIAL PREMATURE CONTRACTIONS
05	NODAL PREMATURE CONTRACTIONS
06	VENTRICULAR PREMATURE CONTRACTIONS
06.1	MULTIFOCAL VPC'S
07	VENTRICULAR ECTOPIC (NOT PREMATURE) CONTRACTIONS
08	BRADYCARDIA, SINUS (RATE UNDER 50 BPM)
08.1	PERSISTANT
08.2	TRANSIENT
10-19	CONDUCTION DEFECTS
10	FIRST DEGREE HEART BLOCK (P-R INTERVAL GREATER THAN 0.20 sec)
11	SINUS ARRHYTHMIA, MARKED (GREATER THAN 25 BPM VARIATION)
12	WANDERING PACEMAKER
13	MOBITZ BLOCK I
13.1	MOBITZ BLOCK I, INTERMITTENT
14	MOBITZ BLOCK II
15	COMPLETE A-V BLOCK

NUMBER	FINDING
20-29	OTHER CONDUCTION DEFECT
20	INCOMPLETE RIGHT BUNDLE BRANCH BLOCK (QRS 0.09-0.11)
21	COMPLETE RIGHT BUNDLE BRANCH BLOCK
22	INCOMPLETE LEFT BUNDLE BRANCH BLOCK (QRS 0.10-0.11)
23	COMPLETE LEFT BUNDLE BRANCH BLOCK
24	WOLF-PARKINSON-WHITE SYNDROME
24.1	INTERMITTENT W-P-W
30-39	T WAVE CHANGES
30	LOW AMPLITUDE OR ISOELECTRIC T WAVES
31	NOTCHED T WAVES
32	INVERTED T WAVES
40-49	S-T SEGMENT CHANGES
40	ISCHEMIC
41	"J" JUNCTIONAL
42	EARLY REPOLARIZATION
43	ELEVATED
90-99	OTHER

FIGURE 3

Percentages of Persons in High and Low Risk Groups Showing Dynamic EKG Patterns with Established Clinical Significance and Dynamic EKG Patterns Other Than Normal

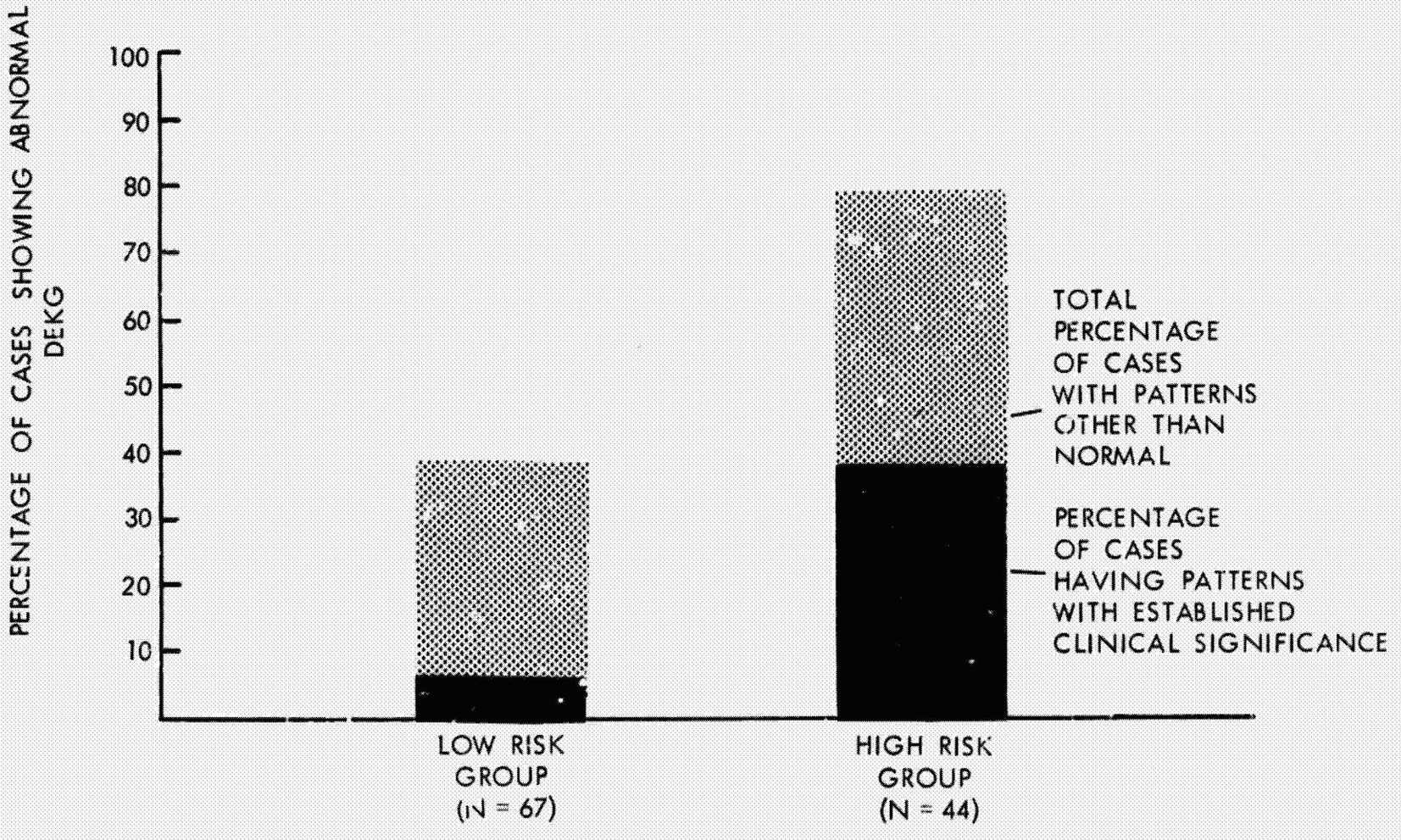

FIGURE 4

Percentages of total population (Base Line) and of high and low risk subpopulations manifesting Fleck list codings at least once for three recordings

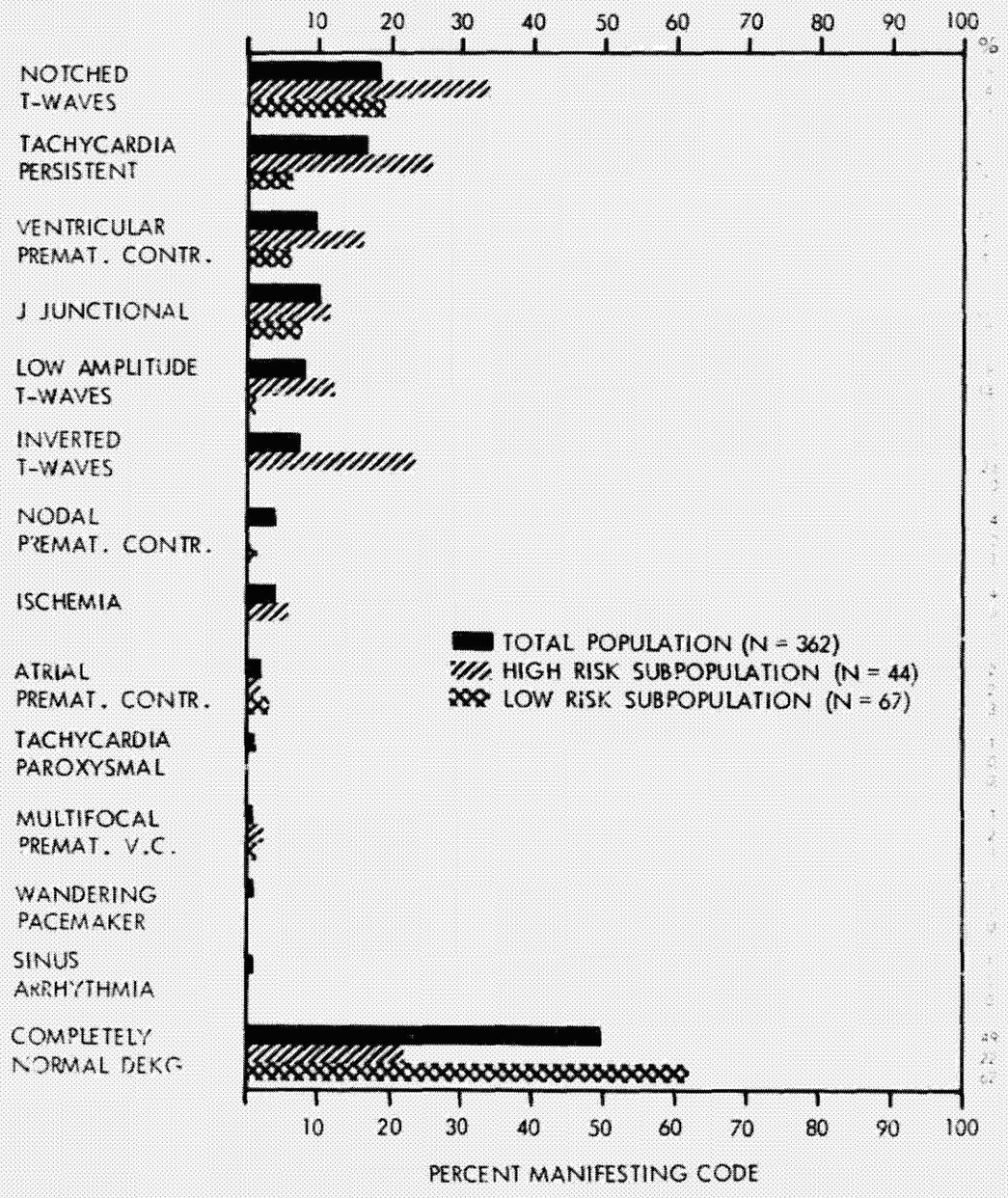

FIGURE 3

Frequencies of Lipid Profile Patterns After 1 to 3 Years of High and Low Motivated Dieting Among 112 Men with Initially Elevated Cholesterol

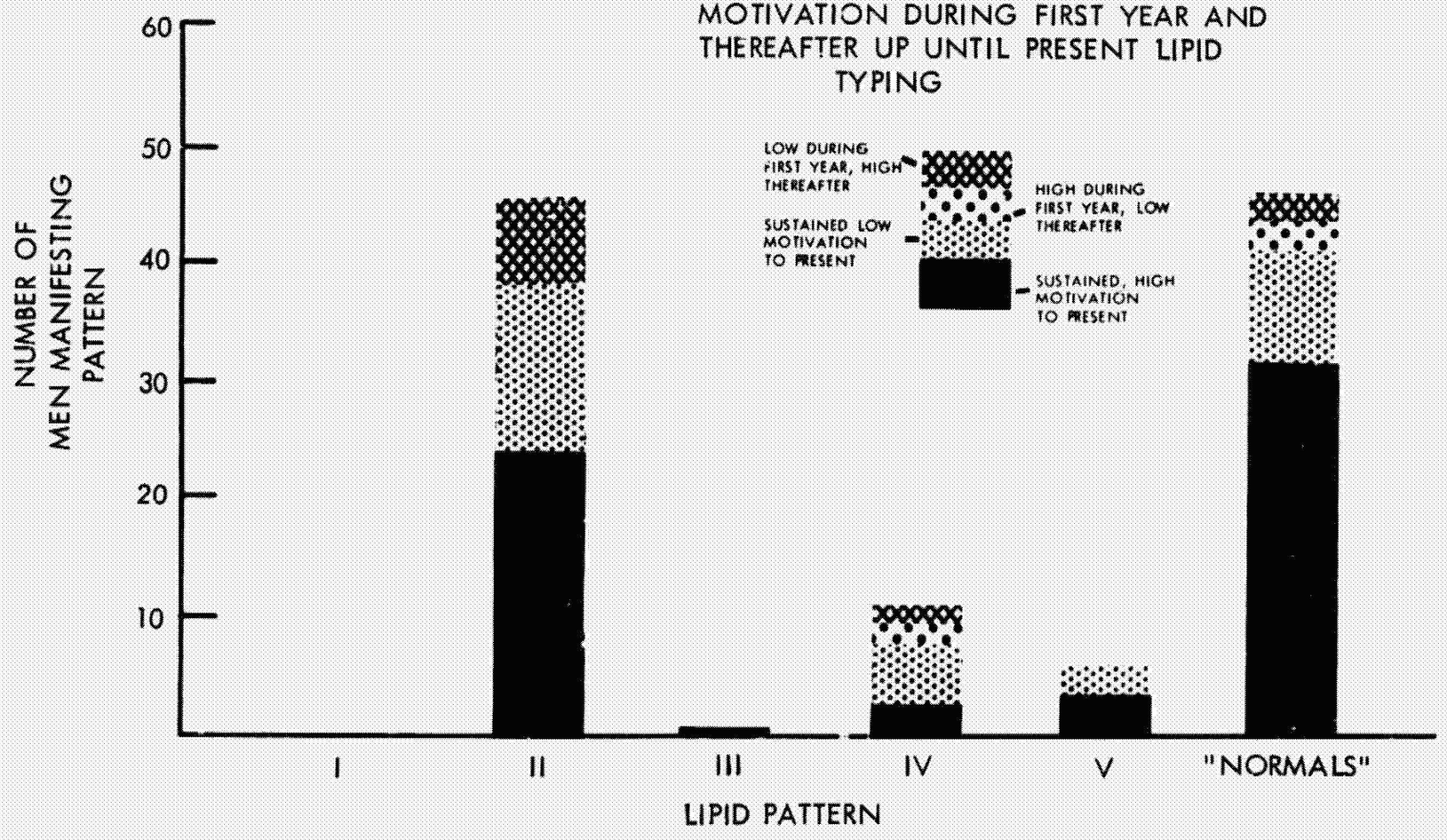

FIGURE 6

N73-17081

THE MOTIVATING INFLUENCE OF RETEST AND REPEATED DIETARY COUNSELING ON CHOLESTEROL REDUCTION

BY

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INTRODUCTION

Within the past five years morbidity and mortality from coronary heart disease has been a consistent major problem within NASA. Most centers have established preventive screening programs aimed at identifying coronary prone individuals so that correction of the coronary risk factors can be accomplished. High risk employees are usually referred to private physicians for more complete treatment and follow up counseling is conducted for those factors amenable to correction.

One of the most important of these coronary risk factors is hypercholesterolemia. Numerous proseptive studies have shown the increased risk of developing coronary heart disease prematurely with increasing serus cholesterol levels. It is important to note that there is a direct relationship between risk and cholesterol concentration and, thus far, there is really no concentration level separating high from low risk individuals.[1] It appears then that at least one measure of the benefit derived from an intervention program is the amount of cholesterol reduction achieved through its dietary counseling.

There are many factors which are likely to influence the amount of cholesterol reduction attainable by dietary counseling. The most

obvious of these is the motivation of the employee to reduce the amount of animal fats and carbohydrates in his diet. Previous studies have also shown that elevated cholesterol levels are related to the Type A personality which is characterized by excessive drive, ambition, involvement in competitive activities, pressure for vocational activity and "sense of time urgency."[2] In a normal population seasonal variation has also been shown to change cholesterol level on the average by about 30 points (mg/%), within the same year, being at its highest during the months from January through April and at its lowest from July through November.[3] Another known factor in hypercholesterolemia control is the age of the patient, since even among healthy men the average cholesterol level for those 20 through 29 is 183 while in succeeding decades it is 210, 230, and finally 240 for those between 50 and 59.[4] A report made at this conference just last year indicated that even among motivated subjects the ability to reduce cholesterol by diet diminishes with age.[5] The influences of other factors such as job stress[6] and physical exercise[7] have not been clearly established but lower levels seem to be mildly related to smaller workload and routine physical exertion. Normal diet and metabolic variations, even in the absence of a typically high cholesterol intake, can create intra-individual variations in cholesterol level by as much as ten to twenty points (mg/%) over

the course of a week. Still another nonsystematized source of variation can be the differences in laboratory procedures especially if a particular test is done in an outside laboratory.

When the physician, then, looks at a measured change in an individual's cholesterol level he is faced with a complex judgment concerning its significance. Some physicians choose to simplify this judgment by disregarding all but extremely elevated levels, i.e., greater than 400. Some eliminate intra-individual variations by repeated tests over the course of a few weeks. This latter practice eliminates short term fluctuations, but, as yet, no set of standardized normal limits has been established for the many systematic, long term factors which are operative. Furthermore, practical judgment based on cholesterol measurements must still be made concerning the progressing state of health of particular persons and, more generally, the value of dietary counseling and follow up in the preventive medicine effort.

In order to establish a firmer basis for these judgments within NASA's Occupational Medicine program, a retrospective pilot study was designed to test for the effect of these known systematic influences on repeated cholesterol measurements taken at Headquarters (HQ) and Goddard Space Flight Center (GSFC). The particular objective of

the study was to see if any improvement in the amount of cholesterol reduction, not attributable to these extraneous systematic influences, was brought about by the policy of continued follow up counseling practiced at Headquarters and GSFC. This policy operates under an assumption similar to that of a "weight watchers club," namely, that increased motivation to diet will be associated with anticipated evaluation of effort and with increased awareness of diet importance to the person's health. The hypothesis we tested was that those persons with hypercholesterolemia who were scheduled for more frequent follow up measures and counseling during the year after discovery would reduce their cholesterol levels to a greater degree than those followed up fewer times.

The truest test of the effect of follow up counseling would, of course, be comparisons between counseled and noncounseled groups, but since everyone was counseled at least once (even if not followed up) we could only test for the effect of relative frequency.

METHOD

Employees at Headquarters and GSFC were given summaries of laboratory findings and other diagnostic tests shortly after their routine physical examinations. At that time, they were advised to take remedial steps to correct any coronary risk factors which appeared significant. In the instance of elevated cholesterol, i.e., levels greater than 250 mg/%, they were instructed to substitute polyunsaturated fats for saturated fats in their diet and to limit their intake of food with high cholesterol content. If they are obese they are also advised to reduce their calorie intake until they have regained their normal weight. Pamphlets containing the calorie values and polyunsaturated-saturated fat values of various foods are given to these men along with specific daily diets recommended by the American Heart Association. They are then informed that they will be recalled in about three months for another blood test to measure their progress in correcting the cholesterol risk factor.

After three months, the nurse calls the employee in for a repeat cholesterol measurement and during a subsequent follow up visit the patient reports how well he has maintained his diet. The physician then judges whether the degree of improvement in cholesterol level warrants a stricter diet or simply the continuation of the current one. This procedure is repeated at three-month intervals as long as the patient continues to show some improvement but still remains above 250 mg/%. If the patient shows no improvement under a very strict diet then he is referred to his private physician for possible drug therapy.

In the present study, routine laboratory reports on men who were tested for cholesterol level as part of physical examinations between January 1968 and January 1970 at HQ and between April 1968 and April 1970 at GSFC were surveyed for cases where the level was reported as greater than 299 mg/%. Although dietary counseling is given to those whose level is greater than 250, this higher level was chosen because counseling is emphasized more for those over 299, and because the likelihood of including an atypical elevation from a basically normal person was reduced. Those who had reported greater than 299 mg/% were also eliminated as having an atypical peak if the pre-elevated, elevated and post-elevated cholesterol level report averaged to less than 250 mg/%. If no pre-elevated report was available, the elevated measure was taken as valid.

Ninety-four cases from HQ and 104 cases from GSFC were thus obtained. After deleting those cases who had either left NASA, were on leave, had never been retested, were atypical or were not interested (See Figure 1 for frequencies) 152 cases remained. These 152 men were given small questionnaires asking them to rate their dietary effort after each time they were retested and counseled. Although the levels reported on successive follow ups were available on a hidden slip, 87 percent of the respondents rated their effort without the help of actual levels. One the same form they reported if they had taken medication to reduce cholesterol, and also filled out a three-item measure of the coronary prone personality (Type A) developed by French.[6] (See Figures 2, 2a, and 2b.)

Since hypercholesterolemia can be caused by other, more primary conditions (See Table 1) those cases whose health record showed the presence of these conditions (i.e., diabetes, hypothyroidism, etc.) were deleted from the analysis. Anyone using drugs to reduce cholesterol was also eliminated. (See Figure 3 for frequencies.)

Thus the final subject pool consisted of 69 subjects from HQ and 68 from GSFC. The variables included in the analysis were:

1. Frequency followed up and counseled after initial counseling. (Varied from 0 to 3 follow ups.)
2. Average level during the 12 months after the year counseled. (mg/%)
3. Expected seasonal variation (scaled from +2 for large expected increase to -2 for large expected decrease due to season alone).
4. Age - (by year of birth).
5. Self-rated motivation · Counseled year (varied from 1 to 4).

6. Self-rate motivation - After counseled year (varied from 1 to 4).

7. Coronary prone personality scale (possible scores ranging from 3 to 15).

8. Amount reduced between first counseling and second year. (mg/%)

9. Initial level at beginning of counseling (mg/%) - to control for the possibility that the more a person was up, the more he came down, regardless of what happened to him.

RESULTS

Despite the broad range of amounts reduced within each frequency of follow up, the effect of continued follow up seemed evident in this sample. Age, expected seasonal changes, and coronary personality score, all previously found related to higher absolute levels, were not found related to amount reduced over a one-year period of counseling. Frequency of follow up, however, was found related to amount reduced ($P < .01$) (see Figure 4).

The difference between the amount reduced at different frequencies of visits is significant ($P < .05$) even if the fourth group (with small N) is deleted from the analysis of variance. The beneficial effect of frequency is evident even after the effects of initial level are held statistically constant (via covariance). Although there was no significant difference in cholesterol level between groups seen for different frequencies of follow up at the beginning of counseling (see Figure 5) there was a highly significant difference at the end of the counseled year ($P < .01$).

Self-rated motivation also had a significant relationship ($P < .05$) to frequency of follow up with those seen more frequently reporting higher diet motivation. (See Figure 6.)

An intercorrelation analyses of the variables showed that motivation during the year counseled also increased with initial level and amount reduced. (See Table 2.)

The size of the correlation between frequency of follow up and amount reduced after holding initial level constant (by partial correlation) was a significant .26 ($P < .01$), showing the independent contribution of follow up frequency to amount reduced.

A correlational analysis of the variables within each of the two sites used in the study showed the expected seasonal variations at HQ ($r=.29$, $P < .05$), and a trend at Goddard for older persons to reduce more ($r=.24$, $P < .05$). The only correlations with amount reduced to remain significant in both total sample and within HQ and GSFC were initial level ($r=.35$, $P < .001$) and frequency of counseling ($r=.22$, $P < .01$) showing the mild but reliable contribution made to cholesterol reduction by frequency of follow up.

DISCUSSION

The current level of understanding of the atherosclerotic process, as reported in the latest publication of the Inter-Society Commission for Heart Disease Resources, indicates that major progress in controlling atherosclerotic disease is possible only by primary prevention--prevention which focuses on reducing first clinical episodes by

inhibiting the development of pre-diagnosed atherosclerosis. Even though the exact nature of the relationship between serum lipid levels and the atheroscherotic process is not yet fully understood, the strength of the relationship, as established in numerous animal and human studies, dictates that practical dietary measures aimed at reducing serum lipids are surely warranted at the present time.

The beneficial effects of diet modification on most cases of hyperlipidemia has been well established. Even though many persons with elevated lipid levels will not return to normal levels by dietary effort alone, most will at least have a substantial reduction in these levels.[3] This previous finding has been confirmed by the present study where persons at all frequencies of counseling had marked reductions in cholesterol level. If the relationship between serum lipid levels and risk of coronary heart disease is indeed continuous, as the Commission Report indicates, then the health of the NASA population has been substantially improved by this dietary counseling. It is likewise encouraging to see the progressive reduction in cholesterol levels and the increased motivation among those patients who are seen more frequently. Despite the great variation in persons' individual response to diet counseling, the "weight watcher" effect does seem operative in this population.

The effect of age in the GSFC subpopulation was the opposite of that anticipated with older persons reducing a greater amount. This effect confirmed a general finding of last year's GSFC presentation

on hypertensives which indicated that older persons are likely to maintain a more conscientious effort in reducing coronary risk factors. This positive influence of age on cholesterol reduction may not be apparent if one considers absolute level alone since last year's GSFC report showed that the absolute level among older persons was higher even after dietary efforts. Since the population discussed last year, however, included all persons above 250 mg/%, the simplest explanation may be that compared to younger persons, older persons are more likely to reduce if their elevation is pronounced, i.e., greater than 300, than if they are closer to their own normal age limits.

The apparent absence of any relationship between coronary proned personality Type A and amount reduced in this study may be due to the brevity of the questionnaire. On the other hand, the relationship between this personality type and elevated cholesterol previously found in nonrestricted populations may not show up in this markedly elevated group. For all practical purposes then, this factor can probably be ignored in follow up counseling unless the patient's life style manifests extreme Type A behavior patterns. In that case personal as well as dietary counseling is appropriate.

A prospective study would be necessary in order to elaborate on these findings more fully. A control group of persons with elevated lipids, for example, should receive no counseling at all until after the year long experiment is completed, while other groups should be counseled at different frequencies during that year. The effect of

age and seasonal variation on the amount reduced, which proved significant in the GSFC and HQ subpopulations, respectively, should also be examined for a clearer analysis of their influence.

A more important variation on the present design would be the inclusion of phenotyping of all personnel by means of the simple method outlined by Fredrickson.[4, 8] From routine determinations of cholesterol, triglycerides and plasma appearance, persons could be placed into phenotype groups. At the end of one year, these groups could be compared for the percentage of persons within each type able to reduce more than 10 percent of their total lipids by dieting[2] for the average amount of reduction attainable within types by diet alone among nonfamial types[3] for the absolute elevation of cholesterol and triglycerides characteristic of each type before and after dieting,[4] the percentage of each type reducing so much that they show a normal profile,[5] and for the effect of different drugs recommended by private physicians for the different endogenous types.

A longer term outcome of this endeavor would be an estimate of the relationship between uncontrolled (versus arrested) hyperlipidemia both across and within types and subsequent episodes of coronary heart disease. The scientific yield of such a study would surely justify the additional effort required, specifically, in laboratory work, in repeated lipid measurements, in closer diet monitoring, and in an occasional electrophoresis where Fredrickson's method left some doubt concerning phenotype.

For the present, we should simply note that while medical science has not yet discovered the clear causal relationships between diet, serum lipids and coronary heart disease, progress has been made in showing a sequential covariation in their increase and decrease. Armstrong, et al., for example, have recently shown that among primates, there is a regression of coronary atherosclerosis with the cessation of a high cholesterol, high saturated fat diet.[9] Similarly, three prospective studies on human subjects, reviewed in the Inter-Society Commission's Report, have shown a consistent reduction in coronary heart disease mortality among groups who were on low saturated fat, low cholesterol diets.[1] Though incomplete design and small numbers made these human studies inconclusive, their consistency gives us promise that current efforts expended in NASA's preventive medicine programs will significantly reduce the future incidence of coronary heart disease among men counseled at our installations.

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Figure 1.

Breakdown by Frequency of Reasons for Nonparticipation Among 198 Persons with Hypercholesterolemia

SITE	REASON FOR NONPARTICIPATION			
	LEFT NASA	TRAVEL OR LEAVE	NOT INTERESTED	ATYPICAL PEAK OR INCOMPLETE DATA
HQ	3	10	5	5
GSFC	7	6	3	7
TOTAL	10	16	8	12

Figure 2. **QUESTIONNAIRE TO PARTICIPANTS WHILE WAITING FOR BLOOD TEST**

For several years the health service has been giving blood tests. In at least one of these tests you showed an elevated cholesterol level. In order for us to tell you whether the elevated cholesterol level is the result of heredity, a consistently faulty diet, or simply of a normal day-to-day fluctuation, we would like you to rate your conscious effort to reduce your cholesterol level by diet over the times we have seen you. We have listed only the dates and eliminated the actual levels in order to keep them from influencing your estimates of your effort. (For example, you might say, "I must have tried in this period because I came down," or "I mustn't have worked very hard because I didn't come down.") Since we want to prevent this, only the dates are listed with a space for X's under each date for your response. It may be hard to remember from dates alone but if you start at the present and fill in the ratings going back in time, it may be easier to do. If you can remember the times only because you remember the doctor's report of the elevated or reduced level, then tear open the attached envelope and look at the levels along with the dates. In general, it's better to make a general estimate of your effort (without looking at levels) if you can remember the time period at all, but if you can't it's better to have the actual levels help you than to make a wild guess. If you must look at the levels for some or all of your effort ratings, then make your rating with a check (✓) instead of an (X) whenever you do this. Try to use the values only to help your memory of your effort. If you allow them to influence your answers when you really can't remember your effort at all, then the information we give you about your health will be to that extent invalid. If you tried to diet part of the time between tests but not all of the time, make a mental average of your effort and rate that.

Figure 2a. Remember, place (X's) for estimates made without the help of the levels and (✓ 's) for those made with it, blanks for no recall.

NAME _____ DATE _____

DATES YOUR CHOLESTEROL LEVEL WAS MONITORED	Date of 1st Value of 300 or over	2nd Sample	3rd Sample	4th Sample	5th Sample	6th Sample	7th Sample	8th Sample	9th Sample	10th Sample
YOUR RATED EFFORT AFTER THAT REPORTED LEVEL										
I strictly limited my diet	—	—	—	—	—	—	—	—	—	—
I made a moderate but continuous effort to cut out the specified excesses	—	—	—	—	—	—	—	—	—	—
I cut down on a few things when I thought of it	—	—	—	—	—	—	—	—	—	—
I really didn't try to control my diet in any additional way	—	—	—	—	—	—	—	—	—	—
If you ever took any medication to reduce cholesterol please indicate the approximate inclusive dates here ⟶										

Figure 2b.

JOHN | **DICK**

JOHN IS THE KIND OF PERSON WHO CONSTANTLY STRIVES TO ADVANCE IN HIS JOB. THIS OFTEN MEANS TAKING ON EXTRA ASSIGNMENTS, BUT JOHN DOESN'T MIND THAT.

DICK THINKS HIS PRESENT POSITION IN THE ORGANIZATION IS QUITE SATISFACTORY. HE DOESN'T FEEL A NEED TO GET AHEAD. AS IT IS, HE HAS ENOUGH WORK TO DO WITHOUT SEEKING MORE.

☐	☐	☐	☐	☐
I am like John	I am more like John than Dick	am halfway between John and Dick	I am more like Dick than John	I am like Dick

* *

BILL | **MIKE**

BILL CAN'T UNDERSTAND HOW SOME PEOPLE CAN BE SO SLOW IN GETTING IN REPORTS AND OTHER DOCUMENTS. IT IRRITATES HIM. IF IT WERE HE, HE WOULD WORK ALL NIGHT TO GET THE JOB IN ON TIME.

MIKE FEELS THAT THERE ARE LIMITS TO THE AMOUNT OF TIME ONE CAN SPEND ON A JOB. HE DOESN'T BECOME ANNOYED IF SOMETHING IS LATE IN ARRIVING AT HIS DESK. HIS FEELING IS THAT IF ONE PUTS IN HIS EIGHT HOURS, HE IS DOING HIS BEST.

☐	☐	☐	☐	☐
I am like Bill	I am more like Bill than Mike	I am halfway between Bill and Mike	I am more like Mike than Bill	I am like Mike

* *

ED | **JIM**

ED DOESN'T LIKE TO FEEL THAT HE IS BEING COMPARED TO OTHERS WHEN HE DOES HIS WORK. FOR HIM, A JOB IS A JOB, AND THE LESS INVOLVED ONE IS IN GETTING AHEAD, THE MORE AGREEABLE RELATIONS CAN BE WITH ONE'S COLLEAGUES.

JIM FEELS THAT HIS JOB IS JUST LIKE PARTICIPATING IN SPORTS BACK AT SCHOOL. THERE IS LOTS OF OPPORTUNITY FOR RECOGNITION. JIM ALSO FEELS THAT ONE CAN LIKEWISE BE COMPETITIVE IN STRIVING AHEAD OF COLLEAGUES.

☐	☐	☐	☐	☐
I am like Ed	I am more like Ed than Jim	I am halfway between Ed and Jim	I am more like Jim than Ed	I am like Jim

Figure 3. **Breakdown by Frequency of Reasons for Noninclusion Among 152 Study Participants**

SITE	REASON FOR NONINCLUSION	
	TAKING MEDICATION	SECONDARY HYPERCHOLESTEROLEMIA
HQ	1	1
GSFC	8	5
TOTAL	9	6

Figure 4. **Mean Cholesterol Level Reduction During the First Year of Counseling Among Groups Seen for Different Frequencies of Followup Visits**

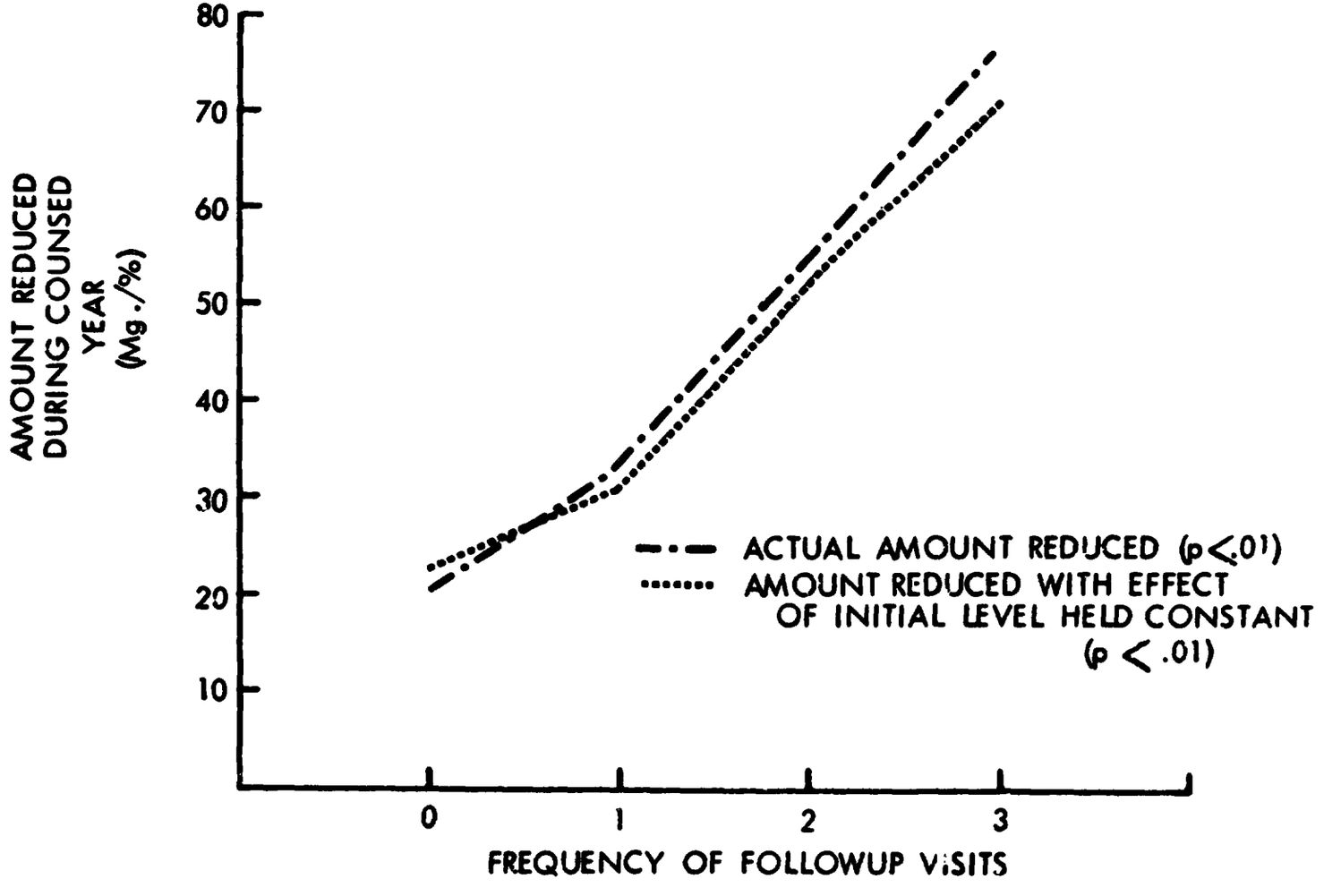


Figure 5. Actual Mean Cholesterol Levels at the Beginning of Counseling and After the First Year of Counseling Among Groups Seen for Different Frequencies of Followup Visits

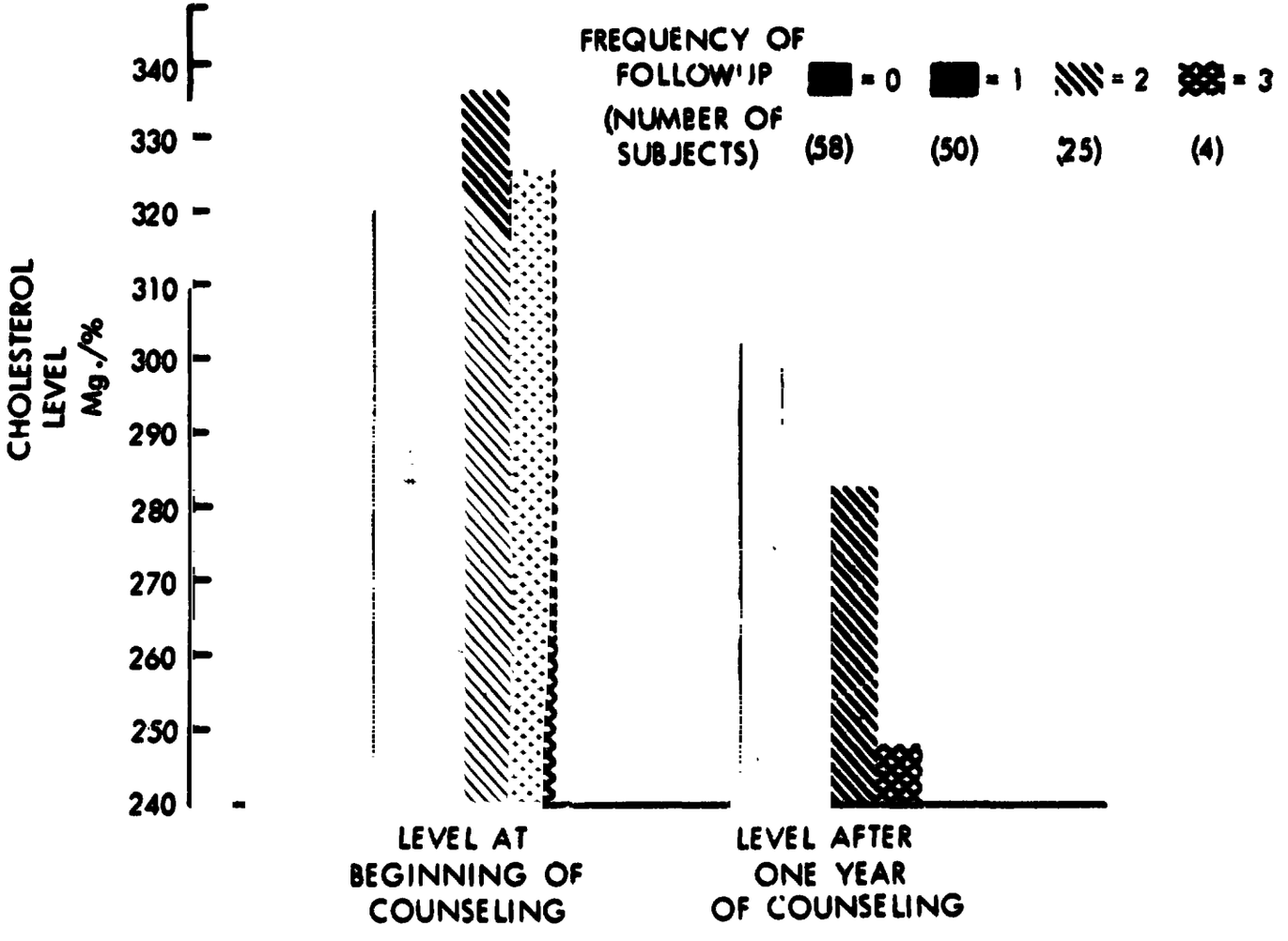
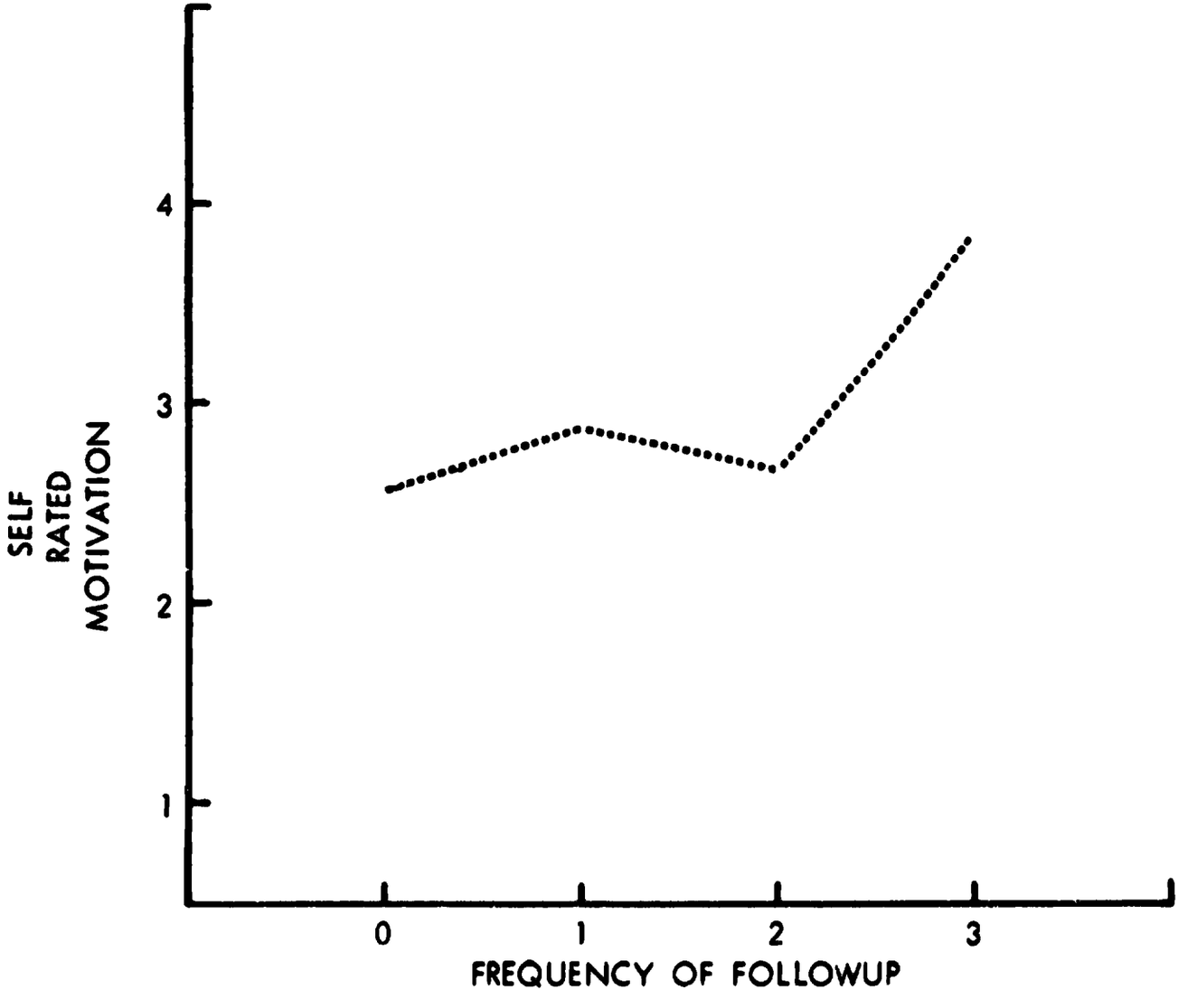


Figure 6. Self Rated Motivation During the First Year of Counseling Among Groups Seen for Different Frequencies of Followup Visits



N72-17082

STRESS STUDIES AT KENNEDY SPACE CENTER
A BACKWARD AND FORWARD LOOK

A. I. Decker, M.D.
Medical Officer
Pan American World Airways, Inc.
Occupational Medicine/Environmental Health Services
Kennedy Space Center

Since 1968, Kennedy Space Center Occupational Health Services has carried out an active program of electrocardiographic stress testing. This has included three procedures: 1) Double Master 2-step test, 2) the dynamic ECG technique utilizing Avionics equipment, and 3) to a lesser extent, submaximal stress testing with a Marco bicycle ergometer. Our experience now totals dual exams (Double Master and DECG) on some 1,000 individuals. Since some of these persons had tests done on more than one occasion, the total number of dual examinations has reached perhaps 1,500 or more.

We have discussed at KSC the possibility of correlating our DECG and other test results with the myocardial infarction experience in our aerospace workers over the same interval of three years. However, this would presently necessitate review of the records of the four local hospitals, since retrieval of appropriate data from the Form 1375's is not possible--at least at KSC itself, I think that Dr. Laurent LaRoche, Pan Am's KSC Medical Director, will bear me out in this regard. Retrieval from the 1375 seems generally unsatisfactory for clinical data; this is most unfortunate because we have some 25,000 records current enough for study--a really sizeable sample. To elaborate on this, you will recall that there are two separate medical facilities in our area--one on Cape Kennedy proper and the other just adjacent to the west on Merritt Island, the two facilities being separated by the beautiful and bountous Banana River. Prior to March 1, of this year, the Cape Kennedy medical unit was directed successfully by Dr. LaRoche over a period of 17 consecutive years, operating with a contract between

Pan Am and the Air Force. The Merritt Island facility at KSC was operated by TWA under a contract with NASA. Since March 1, both of the medical and environmental health units have been run by Pan Am. It's interesting to note that Pan Am's medical records, through the years, have allowed for prompt retrieval of all relevant medical data such as the type we would like to study. This does not seem to be the case for the TWA records, at least on site, via the use of the 1375's.

Over and above correlation of our stress study results with the myocardial infarction experience, I have a continuing hope to analyze all our data in retrospective fashion, much as Dr. Fleck has done at NASA Headquarters. In his presentation at the Cambridge meeting last year, he expressed a desire to "sample other similar and dissimilar occupational groups at the various NASA centers." We would certainly like to participate in such a study since it would surely help to delineate even more reliable coronary risk factors as well as other meaningful medical parameters.

Incidentally, with regard to coronary risk indices, we and probably many of you have just about abandoned the Double Master 2-Step test because we feel it is of little value in a basically healthy work force such as at KSC. We plan to expand greatly the use of submaximal stress testing, especially utilizing the treadmill instead of the bicycle ergometer.

The dynamic ECG experience has been fascinating to me, especially since I had not seen the technique applied to a population sample

similar to our work force (we have done this test almost entirely on males, age 40 to 60). In particular, I was struck by the frequency of startling ST-T changes occurring in presumably normal men as their cardiac activity is monitored with a bi-polar V_4 or V_5 lead throughout a large portion of a work day. Perhaps the cause of these changes has not been clarified in the literature; if so, I have missed it. If not, some effort should be made to assess their significance. It is hard for me to believe that these are mostly physiologic and therefore require no study. Let me amplify this with some slides:

The first four slides reflect a dynamic ECG study on a 46 year old man who is overweight, normotensive, asymptomatic for heart disease. He does have abnormal T-waves in leads V_2-V_6 of his resting ECG and he has a distinctly abnormal Double Master ECG. Note the obvious ST segment depression in the second DECG strip. I think you would agree that this is consistent with myocardial hypoxia.

The next slides represent two DECG's, taken about four weeks apart, on a 40 year old man who is markedly overweight, normotensive, asymptomatic. His resting and Double Master ECG's are normal. Note that the DECG of January is quite normal, the February DECG strikingly abnormal. These DECG's were done by the same method, with the same equipment, by the same technologist. A DECG done four months later was again normal.

The next slides are on a 50 year old man who has well-documented ischemic heart disease with half-block angina. He has a normal resting ECG but clearly abnormal Double Master Test. And note the classically "ischemic" ST-T changes in much of his record. But they are indistinguishable from the changes seen in the previous tracings.

Finally, the last slides are on a 47 year old man who had an acute myocardial infarction six months ago. At this time, note that his DECG is quite normal, as are his resting and Double Master ECG's.

So we have striking ST-T changes in a man who presumably has no heart disease, no ST-T changes in a man who has had a heart attack and so on. This is apparently an area which needs further study. One important observation is that, if we are restricted to looking only for rhythm disturbances as a manifestation of heart disease on the DECG's we are severely compromised because these have been rare in our experience. By contrast, the ST-T changes have been surprisingly common; they would therefore be much more meaningful if indeed we can elucidate their significance.

This brings us to consideration of some of the technical problems we are encountering, and perhaps their solution. With the dynamic ECG's, it has been suggested that the Holter tape recorder (or the way we use it) has enough built-in electronic distortion to account for the ST-T changes just shown. I tend to doubt this but we hope to clarify the situation by calling on the expertise of the NASA bio-instrumentation people. This, in a general sense, is deserving of serious study. By this, I mean that, if the astounding technological knowledge presently existing at the Space Center can be brought to bear on our measurements of physiological and patho-physiological parameters, a meaningful contribution to the life sciences might be made.

Similarly, we are having trouble in producing a consistently clean and clear display with treadmill exercise. We now have to stop the treadmill for 10 seconds out of every minute so as to record cardiac activity legibly. We have been unable to establish whether this is due to unavoidable interference from chest muscle noise or from machinery noise or whether perhaps we just need more sophisticated equipment. The muddled baseline has occurred with various configurations of treadmill recording--that is, with a telemetry technique, with the patient hooked up to a CardioCorder, or with the patient hooked up directly to the ECG. Here we have turned for advise and help to NASA's telemetry specialists who probably know as much about this sort of thing as anyone in the world. I have every confidence in their ability to solve our problem. If they find a commercial piece of equipment doesn't meet their needs, they modify it or build one of their own. In summary, we have at hand all the skillful help we need in such areas as telemetry, instrumentation, computer know-how and so on. We hope we can use it.

Now, in addition to the respective study previously mentioned, we at KSC have been discussing a much more ambitious evaluation of the Space Center work force, this study to be prospective and open-ended. We have been interested in such a study for some time but much recent impetus has been received via a rather chance contact with Dr. Robert Eliot, a cardiologist on the faculty of the University of Florida and the staff of the Gainesville VA Hospital. Dr. Eliot has expressed great interest in such a study and has enlisted the aid of the University's Director of Community Medicine and of a Ph.D. faculty member

who is a behavioral scientist. Also, Dr. LaRoche has leant his active support in this proposed effort. After some discussion it is presently planned to set up an on-going surveillance of a selected population sample of the KSC working force. The study would hopefully establish a meaningful "look" at the relationship, or lack thereof, between life stresses and ischemic heart disease. As our University of Florida friends phrased it, we could thereby "test a prediction model of coronary heart disease within the context of a tightly controlled, relatively homogeneous population." The tentative plan is to monitor the infarction rate of an employee sample as compared to a non-infarction sample, at the same time controlling for variables such as age, sex, past health, job responsibilities, family patterns, personality structure, and so on. Dr. LaRoche has pointed out that the work force at KSC and Cape Kennedy is one of the very few employee groups whose job security varies inversely with the success of their efforts. The more diligent and skillful these people are or become, the more likely that their job will be phased out. If this sounds wrong, think a minute of the various weapons systems perfected to deployment stage. Each was superseded by another company, utilizing mostly their own employees with the addition of some others from the company which had developed the earlier system. This leads to almost a built-in stress factor which premeates the entire work atmosphere throughout the area. This problem will be expected to intensify considerably over at least the next two years. And this stress is not notably ameliorated by what is seemingly the Federal government's current

philosophy regarding contracts with private industry. You will recall my description of the two separate health services contracts prior to March 1 of this year: Pan Am and Air Force at Cape Kennedy, TWA and NASA at KSC, these two changing to a combined contract with Pan Am only. In opening up the bidding for this contract, NASA made it abundantly clear that cost reduction was a very important factor. To bid successfully, Pan Am had no choice but to propose reduction in personnel and personnel costs. As a result, even long-time employees, leaving work Friday under the old contract returned to work the following Monday under the new contract--as brand new employees with consequent major reductions (up to 40%) in pay plus loss of seniority and loss of their accrued fringe benefits. This sort of thing does not warm the cockles of an employee's heart. This philosophy extends to some of the much larger government-industry contracts at KSC and the Cape and has dealt quite a blow to the economy of the area. And, of course, all of this occurred at the time there was a substantial across-the-board pay increase for Civil Service personnel. Perhaps the most striking incident in the change of health services contract involved an industrial hygienist working for TWA. He was making $16,500.00 yearly when his job disappeared with TWA's loss of contract. Under the new contract, Pan Am could offer him as a new employee only $10,600.00 yearly. At the same time he had in his pocket a Civil Service GS-13 rating (salary range $17,761-$23,089). Therefore, is NASA KSC had had an opening for this man they would have hired him at more than he was getting at TWA. However, the contract they reviewed and accepted would allow him a

salary only about half what they themselves indicated they would pay.

Finally, this is a continuing process, in that these contracts are usually set up for a specific period of time and are open to competitive bidding periodically. Therefore, in the present context, it is very difficult for an employee to anticipate any job security per se, let alone any continuation of the benefits that he accrues through long-term service with any given company. Young people can perhaps absorb this type of uncertainty to some extent; however, the KSC work population is steadily aging; it is easy to imagine how stressful this situation can be to men in their late 40's and early 50's. This is all simply to say that, if a meaningful stress study is to be carried out, it would appear that Brevard County in Florida is a good place to do it.

In summary, we have had an interesting but as yet an unevaluated past experience with the aerospace industry at Cape Kennedy and Kennedy Space Center. We are presently involved in attempting to put together a rather intensive, sophisticated and on-going study of the possible relationship between occupational and other stresses and ischemic heart disease. To help overcome any technical problems we encounter, we hope to take a look at some new equipment and to call on the remarkable expertise of the aerospace technicians and engineers.

Perhaps as the space effort diminishes, the astrounding technology of that effort can be brought to bear on another major priority--improvement of the human condition. Finally, I would like to urge a continuing and increasing coordination of the efforts of the various NASA centers. If we embark on any joint projects, it is important that we concentrate on uniformity of policies and procedures so that results will be as meaningful as possible.

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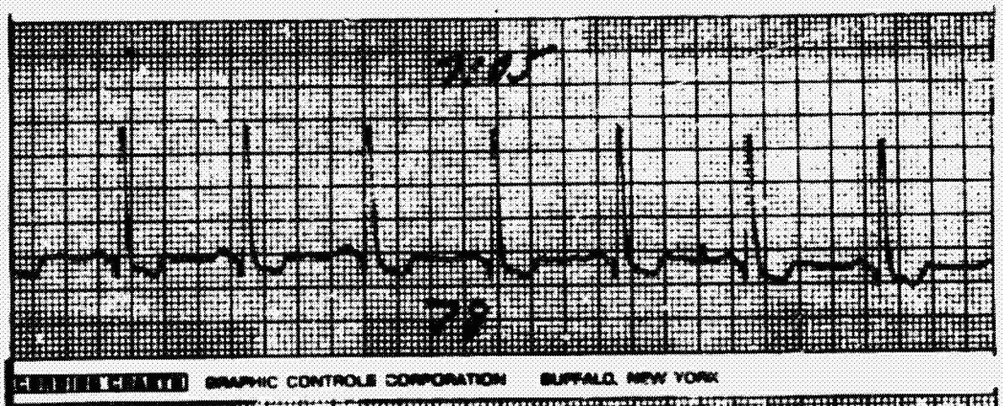

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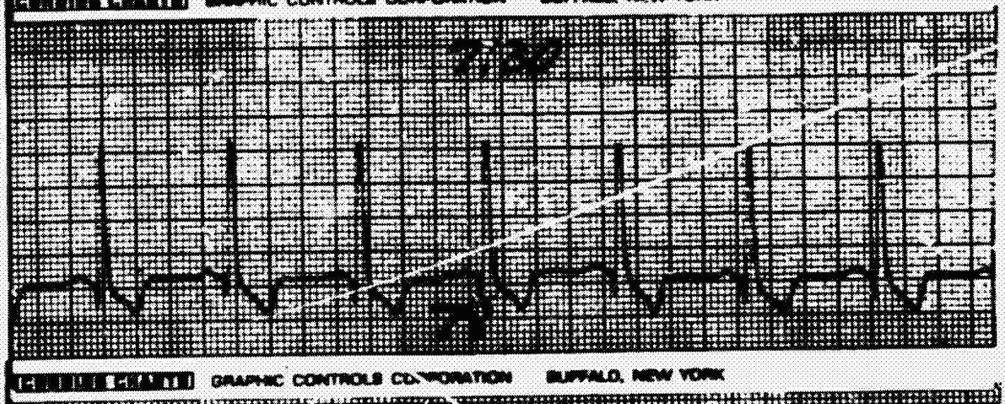

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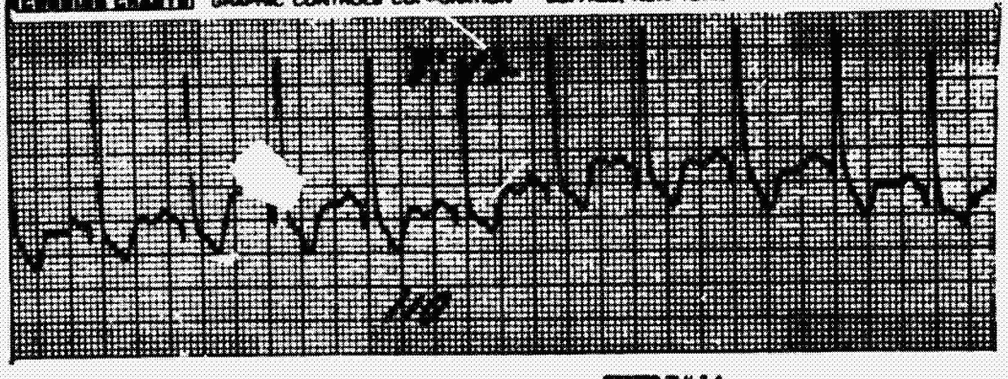
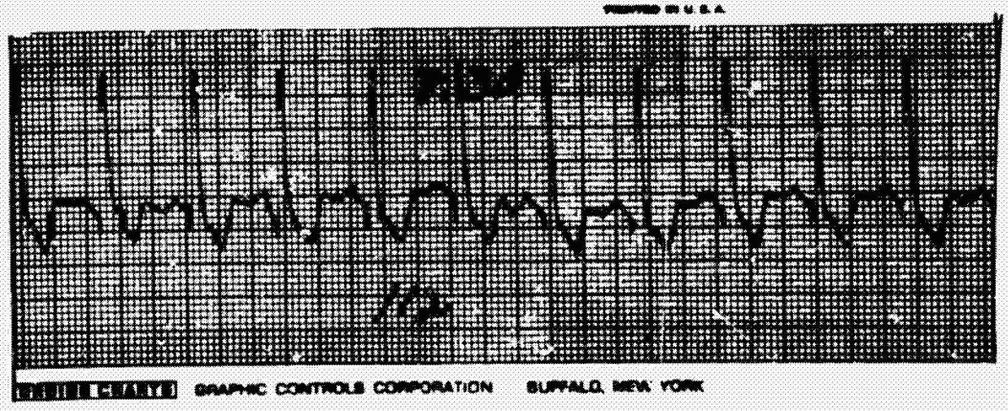


walking



walking

Dynamic ECG

11 Feb. 71

NASA

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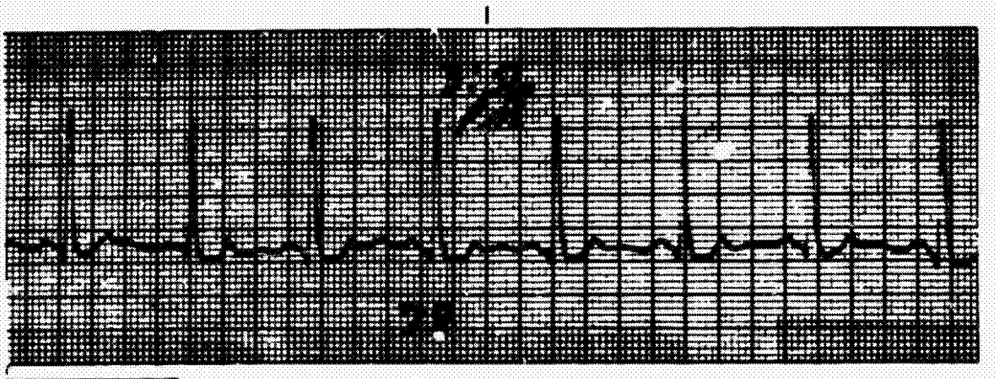
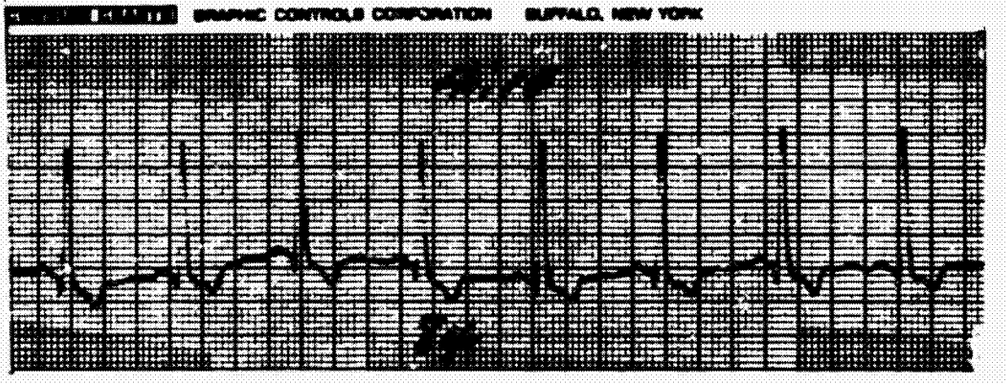
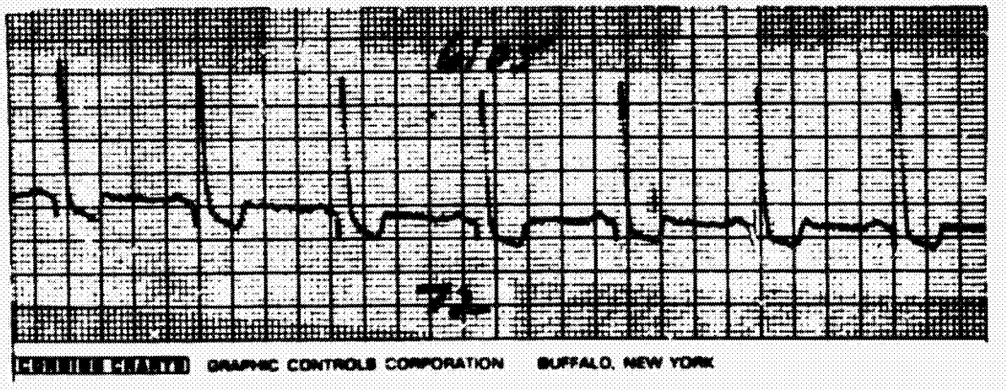


Driving



Routine work



Sitting

Dynamic ECG

11 Feb. 1971

NASA

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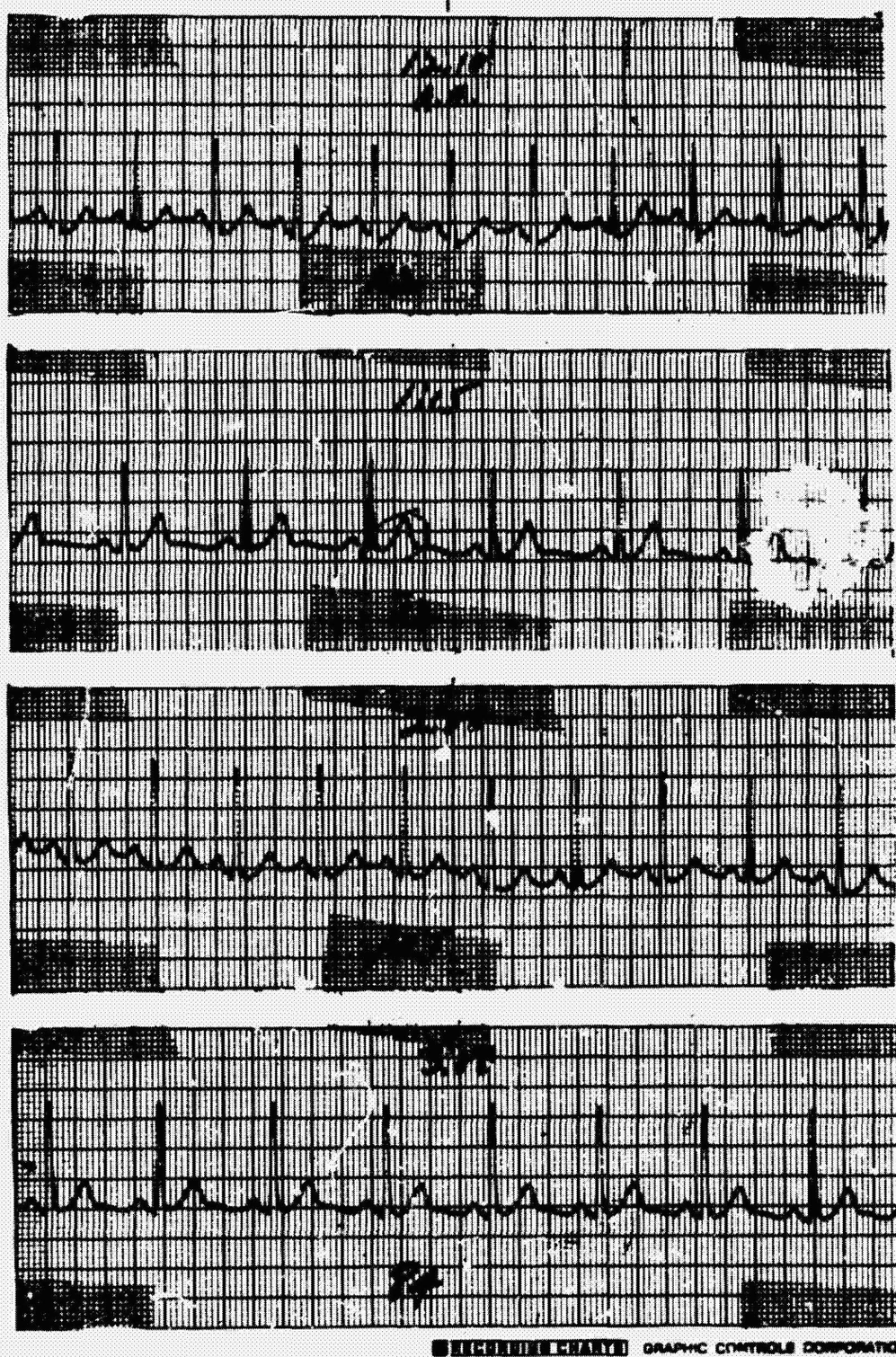

Dynamic ECG

NASA

B Jan 1971

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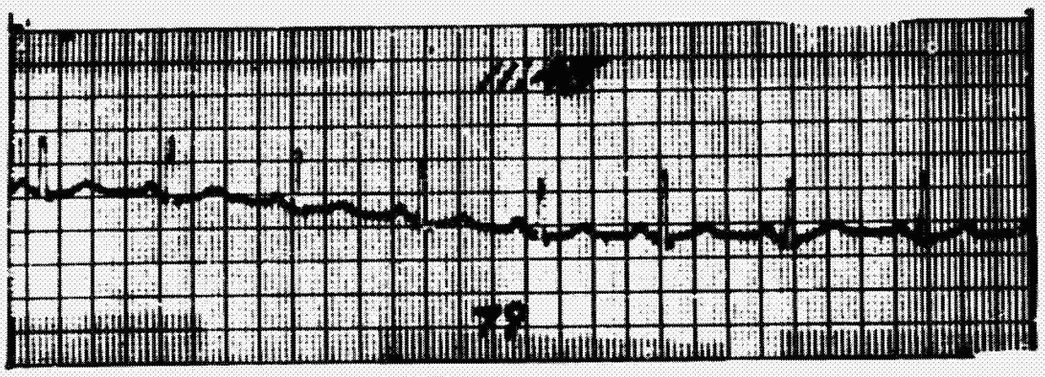
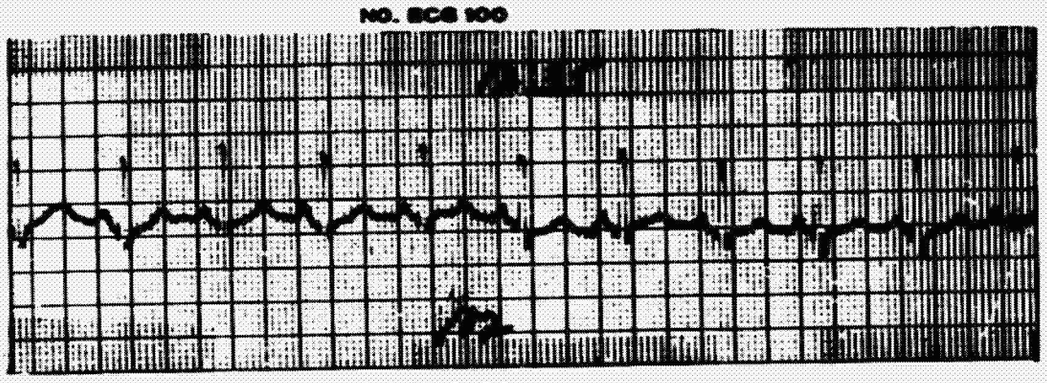


Lunch



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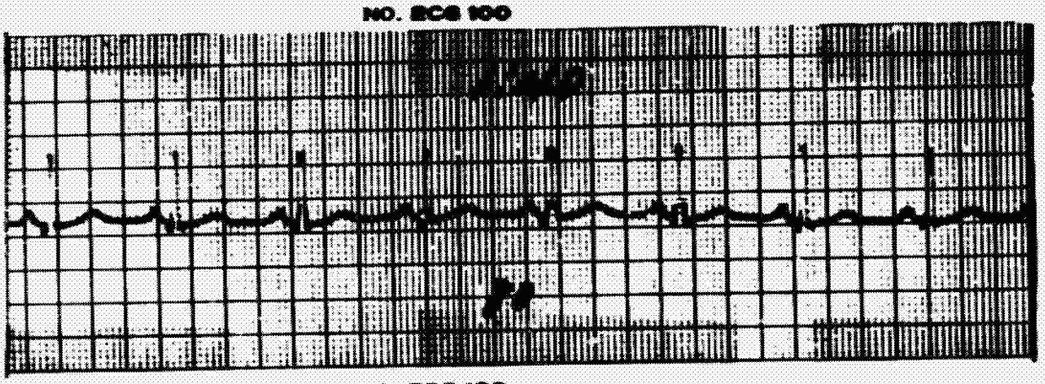

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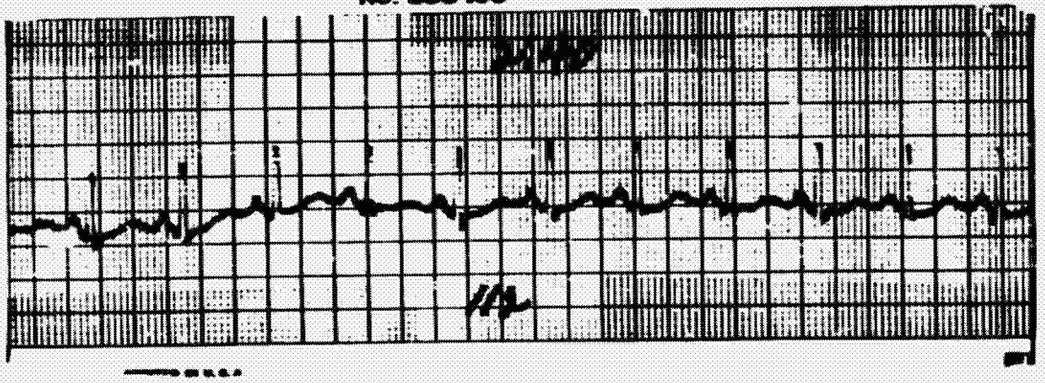
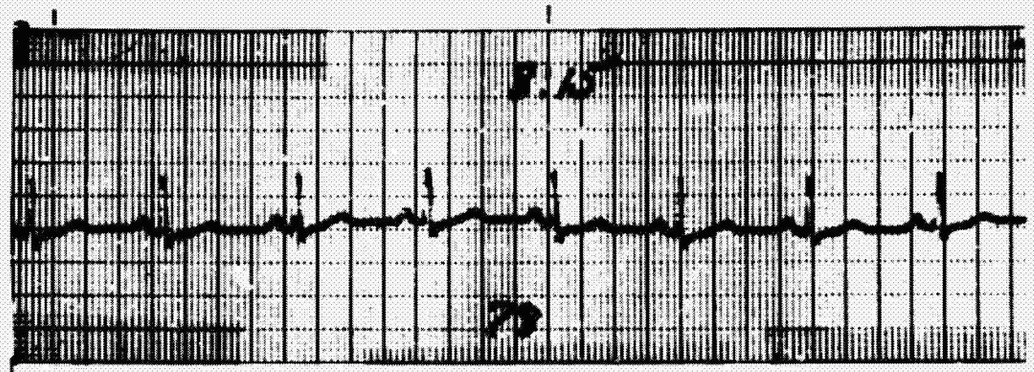


walking

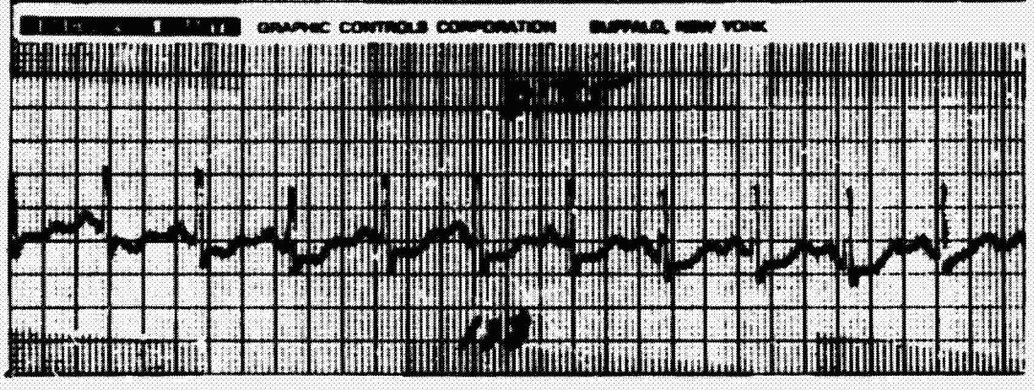
Dynamic ECG

Bne.

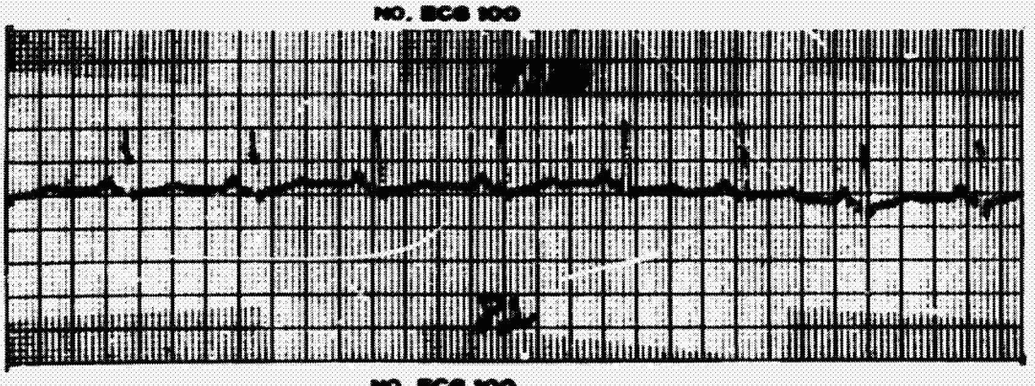
24 Feb 1970



Driving



up 2 flights of steps



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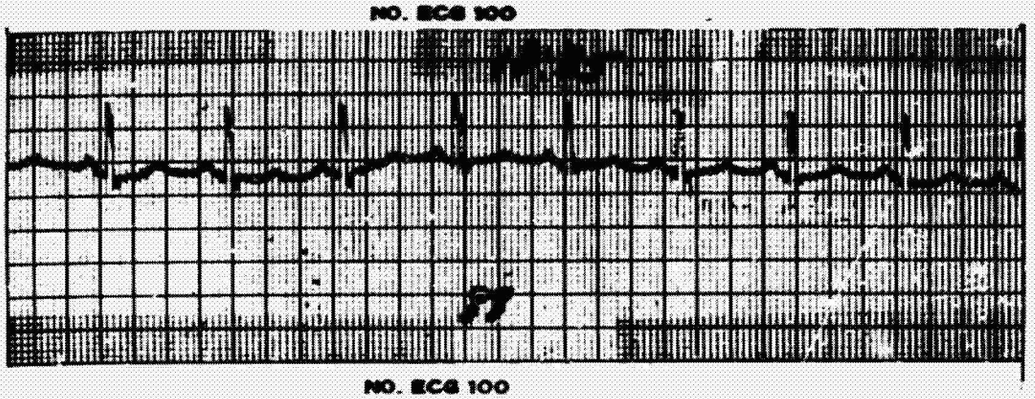
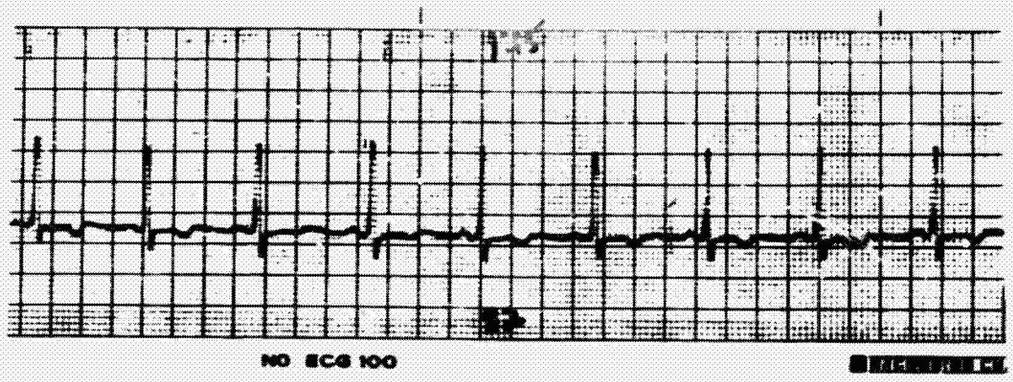


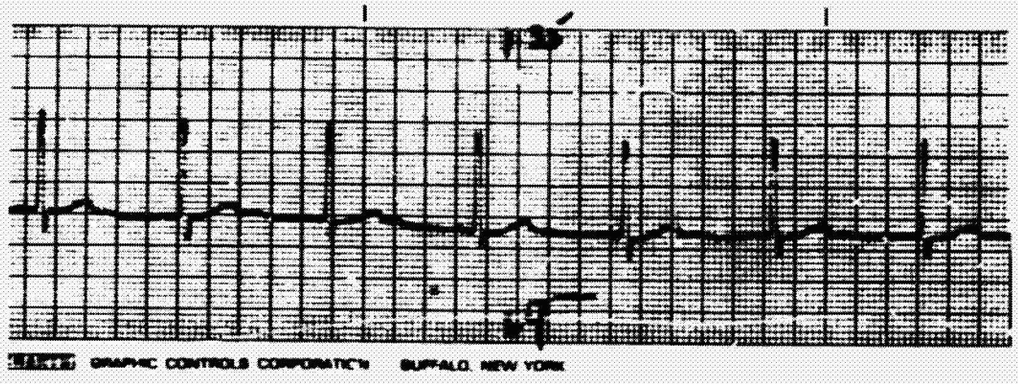
Routine work

Dynamic ECG
24 Feb. 1970

Bx.



ROUTINE DESK WORK



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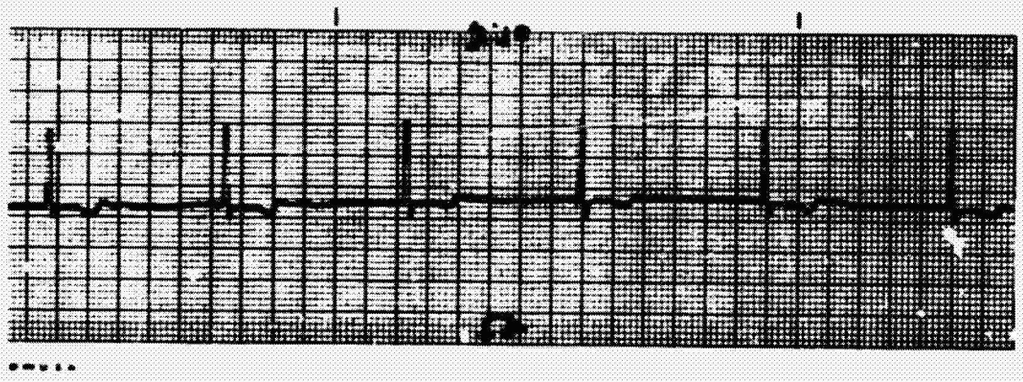
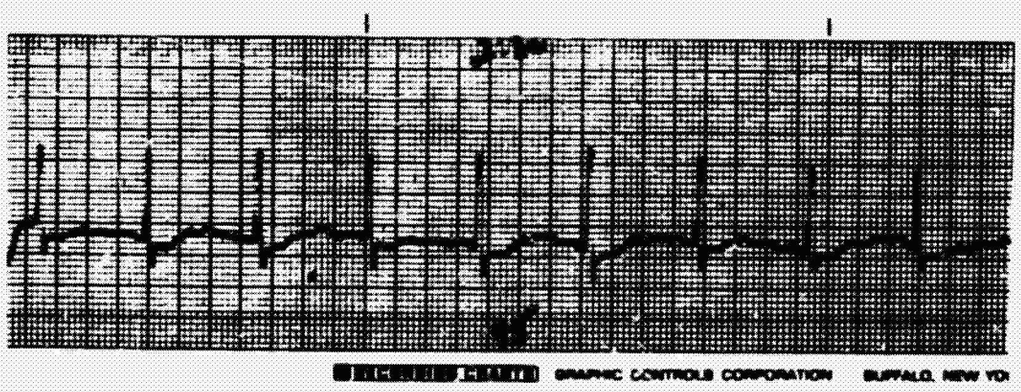


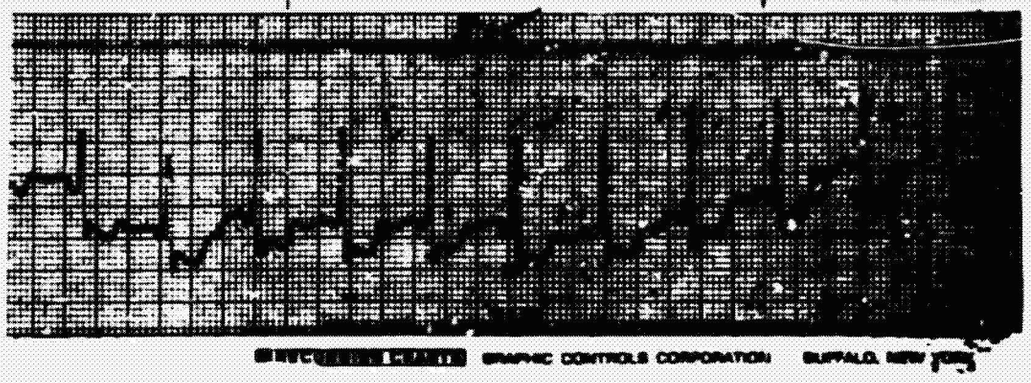
ROUTINE DESK WORK



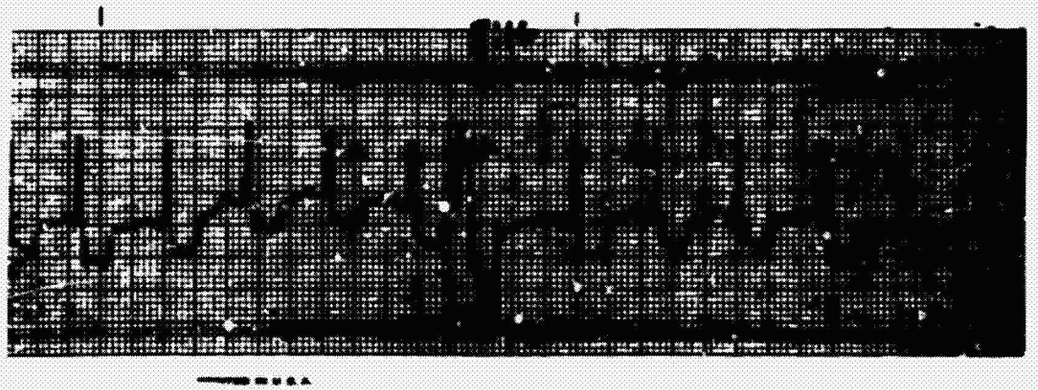
WALKING

Dynamic ECG

13 SEPT 71



WALKING



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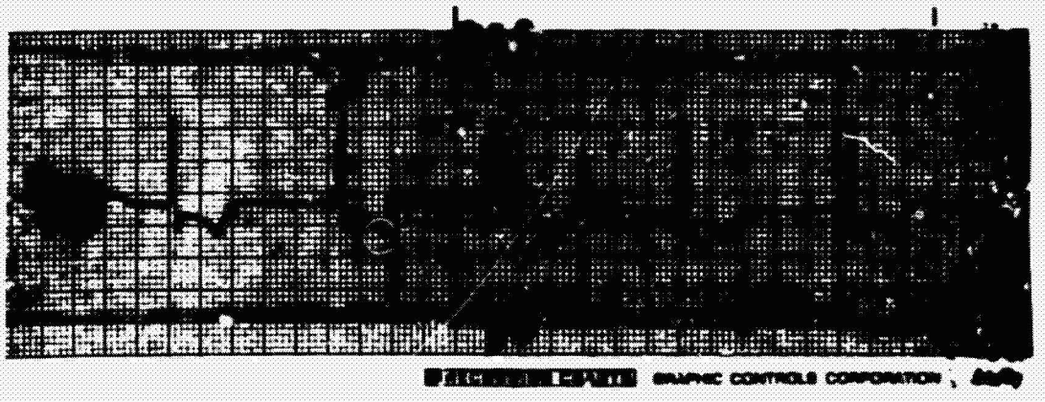
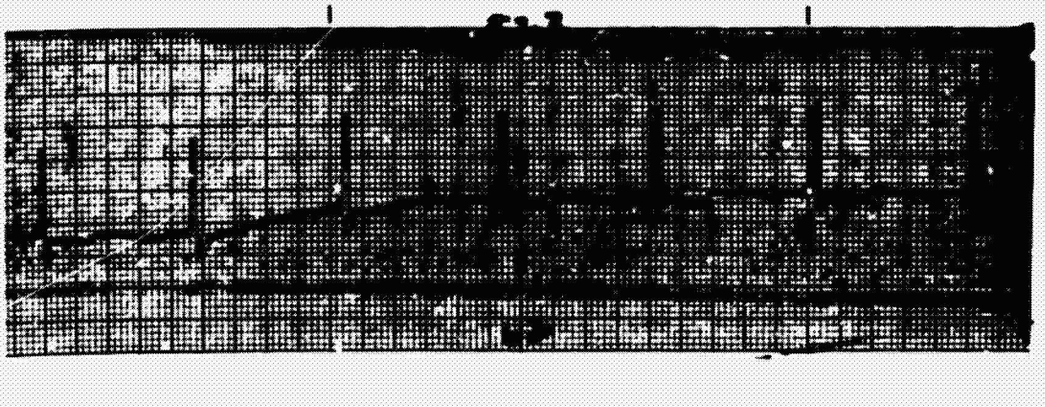


TOOK ONE NITROGLYCERIN TABLET

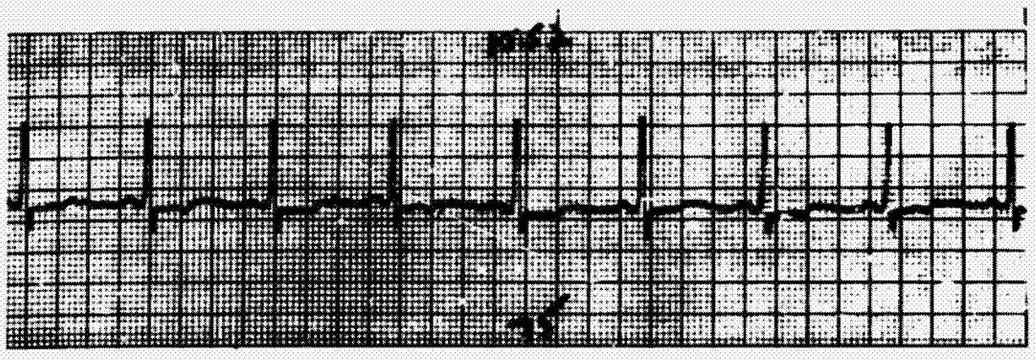


ROUTINE DESK WORK

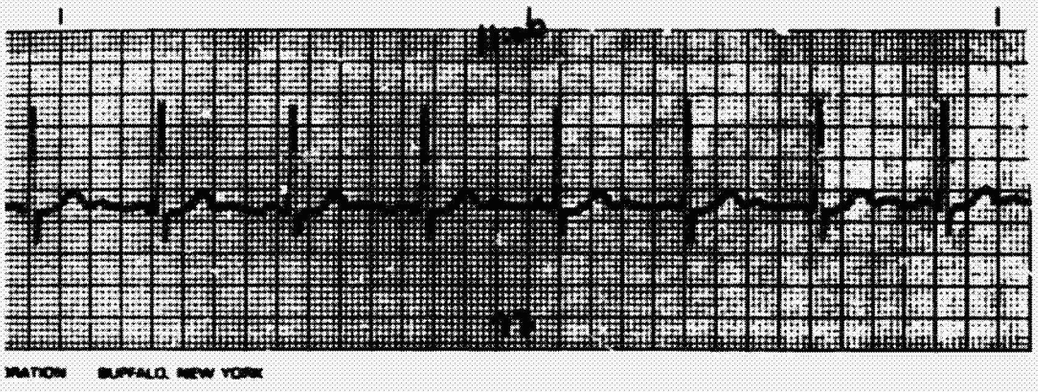
13 SEPT 71

ECG

13 SEPT 71



EATING LUNCH



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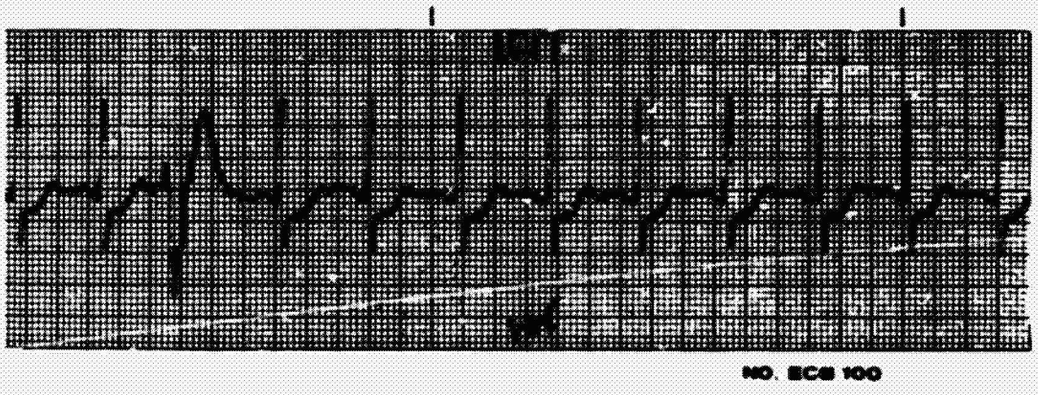

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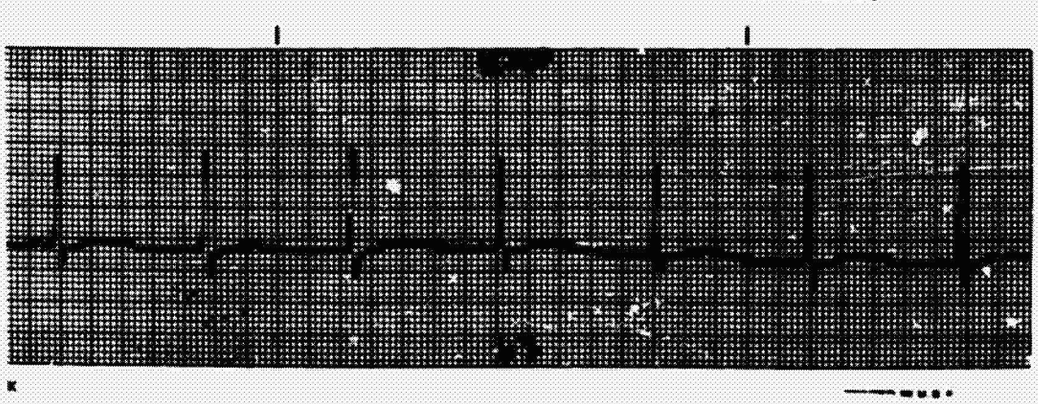
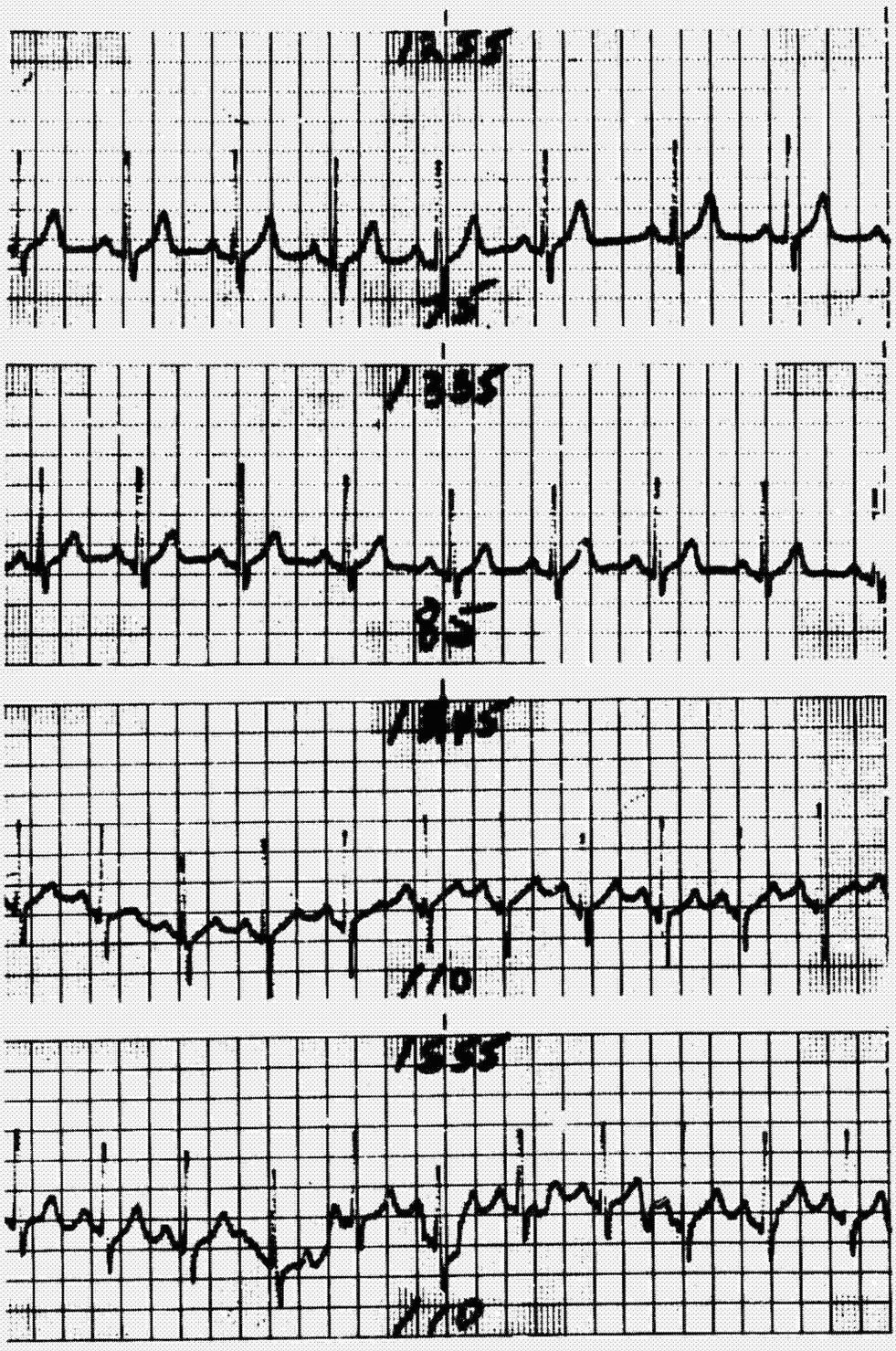


ROUTINE DESK WORK

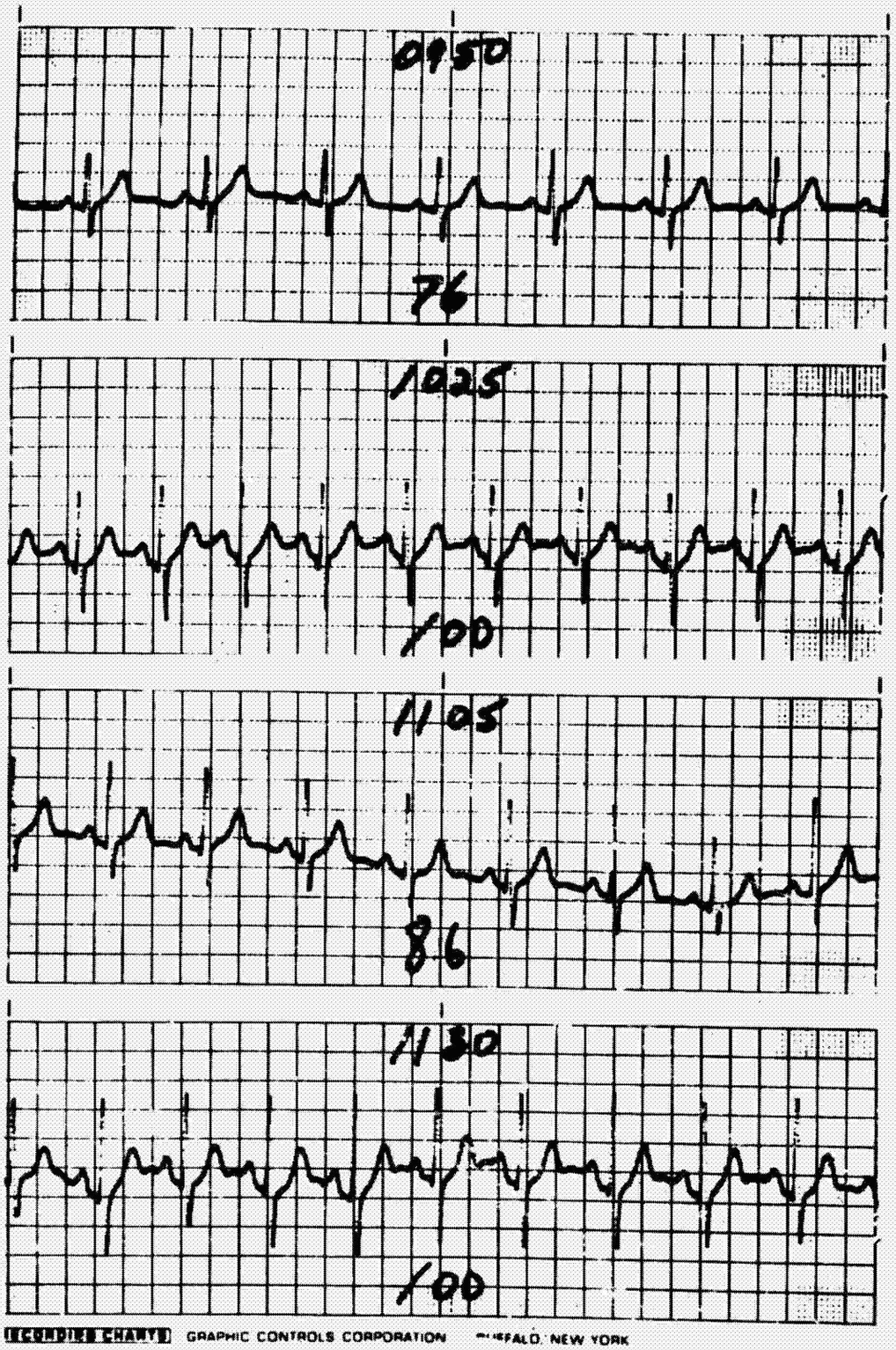
Dynamic ECG

13 SEPT 71



Dynamic ECG
27 Sept. 71

NASA



RECORDER CHART GRAPHIC CONTROLS CORPORATION BUFFALO, NEW YORK

Dynamic ECG
29 Sept 71

LONG-TERM CLINICAL RELATIONSHIPS OF THE VENTRICULAR PREMATURE BEAT

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INTRODUCTION

Ventricular premature beats (V.P.B.'s) are not an uncommon finding in routine electrocardiographic examination.[1] If found in an apparently asymptomatic and otherwise healthy individual, the general and widely accepted opinion of most physicians is that, while they do have some generally undesirable clinical significance, they are extremely common and, in themselves, certainly have no ominous or otherwide deliterious meaning.

On the other hand, the appearance of the V.P.B. during the course of acute myocardial ischemia or infarction is certainly a reasonable cause for at least some concern, since, as is well-known, these premature beats are harbingers of serious and potentially lethal arrhythmias.[2] However, the sudden development of V.P.B.'s in the patient who has just experienced an acute myocardial infarction cannot be viewed in the same light as the slow, indefinite initiation of the same arrhythmia in the "well" individual during the course of his normal daily activity.

Nevertheless, two fairly recent studies have indicated that the presence of V.P.B.'s is associated with higher prevalence rates of both coronary heart disease and sudden death.[3,4] Chiang et al.[3] and Hinkle et al.[4] reported on mortality among those patients with frequent V.P.B.'s as being 6.1 times and 10 times, respectively, greater than that of patients without this electrocardiographic finding.

A higher mortality rate with acute myocardial infarction has also been noted when V.P.B.'s have been present before the acute episode. Insurance data have also indicated a small, but definitely increased, mortality risk in the presence of V.P.B.'s. The present study was therefore undertaken to study the relationship of V.P.B.'s to mortality in acute myocardial infarction among those patients who entered the Lahey Clinic patient population and to report

on the results obtained therefrom.

PATIENTS AND METHODS

The individuals included in the present study were selected from among those patients who had electrocardiographic examination as part of their medical work-up at the Lahey Clinic Foundation during the one year period from January 1, 1967 to December 31, 1967. Twelve thousand, seven hundred and forty-seven (12,747) electrocardiograms (E.C.G.'s), or essentially all E.C.G. studies performed during this period, were reviewed. 539 (4.2%) of these showed the presence of V.P.B.'s and were selected for inclusion in the present test group. On the basis of a careful review of all medical histories as subsequently obtained on these patients, the study group was divided into the following ten categories by the primary medical diagnosis:

a. Cancer

b. Myocardial Infarction, either present or by history

c. Angina Pectoris

d. Other manifestations of Coronary Heart Disease: Atherosclerotic Heart Disease (A.S.H.D.), Congestive Heart Failure (C.H.F.), Atrial Fibrillation (A.F.), or Heart Block (H.B.)

e. Hypertension

f. Valvular Heart Disease

g. Diabetes Mellitus

h. Pulmonary Disease

i. Gastrointestinal Disease

j. Other Miscellaneous or No Definite Condition

Where there was more than one diagnosis present for any single patient, the one that was most serious and potentially lethal was selected for purposes

of grouping. The subgroups and number of patients in each group are listed in Table I.

Control patients were also selected from the same 12,747 patient population group. In each case, the control patient was matched with a test group member by sex, decade of age and potentially most serious diagnosis. The only difference between test and control group members was that the electrocardiogram of the test subject showed one or more V.P.B., while the electrocardiogram of the control subject did not. A certain number of patients in each category could not be matched because of a lack of additional sufficient patients having identical sex, decade of age and diagnosis descriptions. However, in total, the number of unmatched patients represented only 7.6% of all patients studied.

Follow-up of all patients was achieved through a medical questionnaire sent directly to those individuals studied. Where the patients failed to reply, the same questionnaire was sent to their respective physicians, relatives, friends, etc. Additional help was also required from the records of the patient's city clerk office, postmaster, employer and employees union. Finally, results on about 10% of the patients were determined from telephone calls to the patient or to a relative or friend. In this regard, the record of the patient, as available at the Lahey Clinic Foundation, was of significant help and provided much of the above listed information. In all, the ultimate course in 9 patients out of 1,037 individuals comprising the test and control groups could not be determined (less than 1% of the total studied). Patient follow-up was completed between October, 1970 and January 15, 1971. All patients deceased by December 31, 1970 were included for purposes of analysis.

RESULTS

Of the 12,747 electrocardiograms reviewed, 539 showed the presence of one or more ventricular premature beats on the mounted twelve lead electrocardiographic record for a prevalence rate of 42/1000. In 90 patients these were categorized as frequent (8 or more in a 12 lead electrocardiogram).

The number of patients in each decade increased progressively from the second decade of life to the seventh decade. Patients were present up to the ninth decade. Most patients fell in the forty-first to eightieth year, with the largest number in the sixty-first to seventieth year age grouping. The group included 337 males and 202 female patients. The sex ratio was more than 3 males to 2 female patients.

Table I, which shows the various disease categories and number of patients in each category, is further divided into a cardiovascular group (A) and a remaining or non-cardiovascular group (B). There were 221 patients in group A, comprising more than 40% of the total group. The miscellaneous group included a number of medical and surgical disease entities -- representing a smaller number of cases in any single disease classification -- as well as those patients who presented to the Clinic without any significant disease.

Follow-up was obtained on 99.4% of the patients in the study group (those having V.P.B.'s) and on 98.8% of patients in the control group (those without V.P.B.'s).

Study Group

92 patients in the study group (17.1%) died during the follow-up period. A large number of deaths occurred in the age group from 51 to 80 years, with the peaking during ages 61 to 70. There were 70 males and 22 females out of 539 members of the test group who died, showing a significantly higher

incidence of death rate among the male patient population.

Control Group

53 patients out of 498 members of the control group died. The mortality rate was 10.7%, which was significantly lower than the study group ($p < .01$). Again, the maximal number of deaths occurred in the age group from 51 to 80 years, with the peak being in the ages 61 to 70. More male patients died than females (41 to 12), with this ratio being similar to the test group. The deaths in each category showed the same pattern as in the study group, with a maximal incidence in the cardiovascular disease group (34 out of 53 deaths).

The Electrocardiogram

All electrocardiograms were analyzed in the study and the control groups for abnormalities other than the V.P.B. The presence of any of the following abnormalities constituted an abnormal electrocardiogram: left axis deviation of -30° or more, pattern of left ventricular hypertrophy by voltage criteria of ST-T change, left bundle branch block, right bundle branch block, right axis deviation (more than $+100^{\circ}$), intraventricular conduction delay, atrial flutter or fibrillation and ST-T change.

Out of 539 patients in the study group, 289 had normal electrocardiograms in the presence of V.P.B.'s. In 250 individuals from this group, one of the above abnormalities was present, either singularly or in combination. 54 had left axis deviation (L.A.D.); 46 had left ventricular hypertrophy (L.V.H.); 8 had left bundle branch block (L.B.B.B.); 19 had right bundle branch block (R.B.B.B.); 28 had atrial fibrillation (A.F.) and 78 had ST-T wave changes. The electrocardiographic abnormalities were more prevalent in those patients having cardiovascular disease.

In those patients in the study group who died, 76% had an abnormal electrocardiogram and, in the case of only 24%, was the tracing normal. The

electrocardiographic abnormalities and number of deaths are depicted in Table II. Out of 46 patients with an electrocardiographic pattern of L.V.H., 15 died (32%). Ten out of 54 patients with L.A.D. died (18.5%). Three out of 8 patients with L.B.B.B. died (37%), and 7 out of 19 patients with R.B.B.B. died (36%). It was most interesting that 18 out of 45 patients having electrocardiographic evidence of a previous myocardial infarction (40%) were dead at the time of the follow-up period, between 3 and 4 years later.

In the control group, 31 patients had an abnormal electrocardiogram, and Table II notes these findings. In the 31 patients in the control group who died, 58% had an abnormal electrocardiogram, while 42% had a normal tracing. It was interesting that only in the case of patients with L.V.H. did a larger percentage of patients in the control group die (56% vs. 32%). In all other cases, the percentage of deaths was smaller in the control group as compared with the test group. Only in the case of L.A.D. were both percentages essentially the same (18.5% and 25%).

DISCUSSION

Ventricular premature beats are not an uncommon finding in routine electrocardiogram examinations. In clinical practice a majority of patients with V.P.B.'s are not found to have organic heart disease. The prevalence rate in any study will greatly vary with age, sex and type of population studied. Chiang et al. noted an incidence of 3.5% in the Tecumseh Epidemiological Study in their subjects 16 years and older.[3] They noted increasing incidence with age. Our analysis was on a clinic population, and it showed the incidence of 4.2%. We also noted the age trend of increasing frequency in higher age groups.

Unlike other studies we have analyzed this problem further by subdividing

the group of patients with V.P.B.'s into various primary disease categories for which they were seen at the Clinic. Of note was the occurrence of V.P.B.'s in the background of a wide variety of medical problems, but the highest prevalence in the cardiovascular group may imply a closer causal relationship, at least in the higher age groups.

Our recent experience in the coronary care unit (C.C.U.) has greatly increased our awareness of V.P.B.'s as harbingers of serious and potentially lethal arrhythmias in presence of acute myocardial ischemia. The significance of this rhythm disturbance in the ambulatory individual is, however, not clearly established. Insurance mortality statistics have indicated a small but definite mortality risk and a higher likelihood in presence of the other signs of heart disease.

Pell and D'Alonzo noted a significantly higher mortality rate with acute myocardial infarction in individuals who had ventricular premature beats before the acute attack.[5] Linkle and associates in studying the frequency of asymptomatic disturbances of cardiac rhythm and conduction on a random sample of 301 employed American men (median age 55 years) noted ventricular arrhythmias in 62.2% of six hour recordings and reported that these were significantly associated with the presence of coronary heart disease (C.H.D.) with enhanced risk of subsequent death from C.H.D.[4]

The Techmseh study also noted an increasing prevalence of V.P.B.'s with age and an association with a higher prevalence rate of coronary heart disease and incidence of sudden death.[3] Of the 165 persons above the age of 30 years with V.P.B.'s, prevalence of C.H.D. was three times more than in patients without V.P.B.'s.

They also noted a six times higher incidence of sudden death in the V.P.B. group compared to the controls, or 61 per 1,000 vs. 10 per 1,000 during the

six year follow-up period. They concluded that V.P.B.'s carry hazards in their own way, independent of other coronary risk factors and increase the risk of sudden death among persons with overt or subclinical coronary heart disease.

In our present study we have investigated this problem in a more detailed fashion by analyzing the underlying medical conditions and other features of the electrocardiogram for an indication of both the status of the myocardium and the risk of increased mortality. Because of the general and widely held notion that patients having V.P.B.'s also tend to have a significantly greater likelihood of sudden death -- with this figure ranging somewhere between 6.1 and 10 times the non-V.P.B. patient figure[3,4] -- substantial effort was placed upon designing a study which would establish in some meaningful way the presence or absence of this significant relationship.

To eliminate the effects of age, sex and seemingly unrelated disease on mortality, a primary goal of this research was to carefully match study and control group patients by age, sex and most significant diagnosis, if any. As noted previously, 17.1% of patients in the study (V.P.B. group) died during the 3-4 year follow-up period, as contrasted with 10.7% of patients in the control group. It was possible to learn of results in these two patient populations, numbering 1,037 individuals, in all but 9, or over 99% of all cases. While it was not possible to determine exact causes of death in these patients, it is estimated that deaths due to coronary heart disease comprise at least 60-65% of the total. Documentation of this figure can also be gained from the data of Table I which further indicates the importance of heart disease in determining patient course and outcome.

In other words, in this carefully matched investigation, the likelihood of death in the study or V.P.B. group was only 1.6 times that of the control or non-V.P.B. group. It should be noted that this figure, although

statistically significant ($p < .01$), is substantially less than the 6.1 to 10 times figures reported elsewhere.[3,4] Its difference from these data is believed to be due primarily to the carefully controlled nature of this study rather than to other possible factors.

It is also interesting, in comparing the relative rankings of disease as established for this study and as shown particularly by the controls in Table I, that there is a progressive decrease in percentage of patients dying from different causes. The most notable exception is that only 1 of 23 control patients with atherosclerotic cardiovascular disease died during the test period (4.3%) as compared with 11 of 30 patients (36.6%) in the study group. Although there might be some as yet unexplained reason for this very significant difference, the present investigators do not present such a claim and are inclined to attribute this difference largely to chance alone.

We analyzed the electrocardiogram further to see if there were other factors in it that were important in predicting outcome. There were 289 normal E.C.G.'s in the study group and 355 in the control group. The mortalities in these two groups were 7.5% and 6.2% which were not significantly different. However, in presence of L.V.H., 32% and 56% of the patients in the study and control groups died during the next 3 years, a higher figure in the group without V.P.B.'s.

The present study cannot yield a causal relationship between the presence of V.P.B.'s and increased mortality rates. It is, however, clear that the incidence of V.P.B.'s increases with age and follows closely the age trend of the development of coronary heart disease. They are more prevalent in the presence of a diseased myocardium, of which it can be a manifestation -- in the absence of other causes. However, because of the nature of our follow-ups, we cannot draw any conclusions on its relationship, if any, to the occurrence of sudden death.

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SUBGROUPS, PATIENT COMPOSITION AND DEATHS IN EACH

		V.P.B.				CONTROL			
	Disease Category	Number	Followed	Died	% Died	Number	Followed	Died	% Died
I.	CANCER	25	25	10	40%	19	19	11	56%
II.	INFARCTION	60	60	24	40%	53	52	12	23%
III.	ANGINA	41	40	15	38.7%	38	38	10	27%
IV.	ASHD, CHF	30	30	11	36.6%	23	23	1	4.3%
V.	VALVULAR	19	19	4	21%	14	14	2	14%
VI.	HYPERTENSION	71	71	12	17%	69	67	9	13%
VII.	DIABETES	35	35	3	8.5%	35	35	1	2.8%
VIII.	LUNG DIS.	50	50	5	10%	50	50	3	6%
IX.	G.I. DIS.	39	39	3	7.7%	34	34	0	0%
X.	MISC.	169	167	5	3%	163	160	4	2.5%
TOTALS		539	536	92	17.1%	498	492	53	10.7%

SPECIFIC E.K.G. ABNORMALITIES AND NUMBERS OF DEATHS

	STUDY GROUP			CONTROL GROUP		
ABNORMALITY	NUMBER	DIED	PERCENT	NUMBER	DIED	PERCENT
ST-T Wave Abnormality	78	17	21%	45	5	11%
L. V. H.	46	15	32%	25	14	56%
R.B.B.B.	19	7	36%	10	2	20%
L.B.B.B.	8	3	37%	3	0	0%
L. A. D.	54	10	18.5%	16	4	25%
R. A. D.	0	0	0%	3	1	33%
Atrial Fibrillation	28	10	35%	4	0	0%
Myocardial Infarction	45	18	40%	33	7	21%

N73-17084

"THE CORONARY PATIENT IN INDUSTRY"

Benjamin Schuster, M.D., F.A.C.C.

"THE CORONARY PATIENT IN INDUSTRY"

Introduction

The purpose of this paper is to discuss the coronary patient as he pertains to industry and particularly to NASA. I will discuss the concept of precoronary care, the acute attack which may develop while on the job, and the return of the cardiac patient to work. The underlying theme will be the prevention of sudden death due to coronary disease, since we know that the majority of coronary patients will return to work, if he survives the initial attack.

The problem of sudden coronary death resides not in the hospital but rather in the pre-hospital phase occurring within the community and within industry. It has been demonstrated that approximately 70% of patients dying from coronary heart disease never reach a hospital. Death is frequently sudden, unexpected, and may be nearly instantaneous. Of the more than 500,000 persons who die annually of coronary heart disease, 60% of these are sudden deaths. There are also about 500,000 annual hospital admissions for acute myocardial infarction of whom 15 to 30% die during hospitalization. At present, most of our major resources of research and medical practice are concentrated upon the hospitalized patient with acute myocardial infarction and especially patients whose illness is complicated by cardiogenic shock or severe heart failure. Unfortunately, the prognosis of these patients is relatively poor, even if these complications are overcome. By contrast, it has been noted that there has been relatively little study of sudden death until recently, despite the fact that these victims frequently have a reversible derangement and a good chance of long term survival.

In the past decade, there has been an increasing emphasis on reduction of in hospital mortality from acute myocardial infarction. This has been significantly reduced primarily by the application of the concept of surveillance and therapy in the specialized environment of the coronary care unit. In an effective coronary care unit a reduction of 50% of the early hospital mortality rate has already been reported. This reduced mortality has been attributed to the prompt detection, effective prevention and treatment of life-threatening cardiac arrhythmias by means of specific drug therapy, defibrillation, and pacemaker insertion. The results of intensive research in the pathophysiology of cardiac failure and the development of more successful therapy may reduce this mortality in the future. We can now apply the lessons learned from the surveillance and monitoring of in hospital patients to the patient before he reaches the hospital.

A major thrust in the study of this problem has been started by the Interim Society Commission for Heart Disease Resources under the auspices of the American Heart Association and United States Public Health Service. An attempt is being made to study the patient before he ever gets to the hospital, and to understand those mechanisms which may result in sudden death. Statistics demonstrate similar life span for patients who have been successfully resuscitated from cardiac arrest or ventricular fibrillation compared to those with similar myocardial infarction. It is important to keep this fact in mind.

In view of the high mortality from acute myocardial infarction within the first 12-24 hours after onset of symptoms, it is essential that the patient be brought into an optimal system of coronary care as rapidly as possible. There must be public and professional education regarding the early warning signs, and there must be some organized attempt to provide more prompt treatment for the patients who suffer acute myocardial infarction. The resources of industry should be so organized that a system of stratified coronary care can be implemented which will significantly enhance the utilization of manpower and facilities. Of course, this will vary with local needs and existing resources, but with effective planning this can be adopted to meet the needs of each community.

First there should be some emphasis on <u>education</u> for early care.

<u>A. Public Education</u>

The first few hours after the onset of symptoms suggestive of acute myocardial infarction are critical since the high mortality during this time is presumably due to preventable and treatable occurrence of ventricular fibrillation. Ideally, individuals with these symptoms should be placed under competent medical surveillance within one to two hours after onset of symptoms.

The most frequent and important cause for delay in the patient's indecision when he develops oppressive chest pain is lack of information regarding the significance of the symptoms and the urgency for seeking immediate medical

care. Another factor may be the denial of the importance of chest discomfort by the patient because of the fear of myocardial infarction and its consequences. There may also be misinterpretation of symptoms as reflecting disorders of other organ systems such as indigestion relating to stomach trouble. There may also be failure to have an established relationship or channel to the personal physician or industrial physician who can be contacted at the time of an emergency. Finally, there may be ignorance of how to rapidly enter the system and other psychologic, socioeconomic and physical barriers hindering rapid entry into the system.

Many of these problems can be corrected by a major educational program directed to the employee to teach the frequency of coronary artery disease, the common early symptoms of acute myocardial infarction, and the effectiveness of prompt medical care in altering the immediate prognosis. Individuals, particularly those who are middle-aged and without a history of angina, should seek immediate attention if they develop severe or oppressive discomfort in the retrosternal region, especially if it radiates to the arms and neck and does not promptly disappear. Individuals at high risk for coronary artery disease should be identified because they are a particular target population for this educational message. This group includes those with hypertension, a history of cigarette smoking, hyperlipidemia and diabetes, and those with previous history of angina or infarction. Also, all patients at high risk of developing acute coronary disease should be instructed in specific steps to take when they experience symptoms suggestive of acute myocardial

infarction and cannot immediately reach their physician.

It is recognized that expanded public education may produce a number of false alarms. However, the number of lives saved should justify the inconvenience in cost in terms of time and dollars.

Equally important in employee education is the clear identification for the patient of effective pathways for rapid entry into the system of emergency coronary care. The industrial physician, and those charged with maintaining health of the employees, should instruct the employees regarding clear-cut emergency measures in time of such illness.

F. Professional Education:

The health profession must recognize that more than half the patients with acute myocardial infarctions have prodromal symptoms including progressive or crescendo chest pain within one week before the onset of acute attack and they frequently have consulted a physician during this time. Solomon and his group have reported that of 100 patients reaching a coronary care unit, 65 had significant symptoms of heart disease during the month prior to hospitalization for acute infarction. In patients dying suddenly within the community, prodromal symptoms presumably also occur, although the real incidence is unknown. Kuller et al found that 24% of coronary heart disease victims with sudden death had seen a physician one week prior to death, though the reasons for the visit were not determined. In Goteborg, Sweden,

Tibblin noted that 1/3 of patients dying suddenly had seen their physicians within two days and 1/2 within two weeks preceding death. The major complaints were changing anginal pattern and unusual fatigue. The Baltimore study indicated that 1/4 of all sudden death coronary heart disease victims had symptoms lasting from 2 to 24 hours. When unwitnessed deaths were excluded, 1/3 of those afflicted had long or lasting symptoms.

In order to improve response of the individual seeking help, physicians and other health personnel likely to make primary contact with the patient experiencing symptoms should be educated in the following areas:

A. Recognition of signs and symptoms of impending acute myocardial infarction.

B. Familiarity with community resources and facilities so that definitive coronary care can be instituted rapidly as possible.

C. The ability to perform cardiopulmonary resuscitation.

D. Understanding by the physician of indication and uses of basic medications and treatment of cardiac arrhythmias.

Physicians should have available appropriate medications for the treatment of cardiac emergencies. Among recent proposals recommended is the use in high risk groups of self-administered drugs such as Atropine, Lidocaine, as soon as symptoms are recognized. However, this approach cannot be recommended until its efficacy has been proven by further investigation. However, the physician himself should have considerable familiarity with such drugs as Digitalis, Lidocaine, Atropine, Propanolol, and Isoproterenol.

It behooves those charged with the health care of the personnel of the NASA facilities to have a cardiac monitor on the premises so that the rate and rhythm of the heart could be observed. There should be an electrical defibrillator handy and the physician and paramedical personnel should be instructed in the proper use of this equipment. Not only the physician, but the paramedical personnel should also receive instruction in the cardiopulmonary resuscitative measures. Prompt institution of such measures may be life-saving in many instances. Many years ago, Dr. Claude Beck, a pioneer in heart surgery, coined the term "hearts too good to die". This applies to many individuals who die suddenly of coronary disease due to ventricular fibrillation or other arrhythmias. These could be promptly corrected and the individual restored to a useful productive life eventually. We now recognize this fact because we have resuscitated so many individuals in hospitals and they leave the hospital alive and approximately 70 to 80% of these patients are ultimately able to return to their jobs.

The Concept of "Pre-Coronary Care":

If the high mortality from coronary heart disease is to be significantly reduced in the near future, it will most probably be by identifying and treating the individual with the high risk from sudden death before he ever develops the acute attack. As stated earlier in my talk, we already recognize individuals with hypertension, hyperlipidemia, diabetes, heavy cigarette smokers, and those with a strong hereditary background having a greater risk for coronary heart disease. However, we now have available

information which provides a larger framework for current action. Statistics show that more than half of sudden coronary artery disease deaths come from a definable group having either previous myocardial infarction, angina pectoris, or known "risk factors".

This paper is not concerned with the treatment of the hospitalized patient, but I do want to emphasize the urgency and importance of education and treatment of some of these patients prior to hospitalization. There is a compelling necessity to determine who is most threatened among the groups suffering acute heart attacks. One method for determining this risk is based on the hypothesis that sudden death from ventricular fibrillation is almost invariably heralded by ventricular premature beats and that the suppression of these ventricular premature beats prevents the occurrence of ventricular fibrillation. Recent epidemiologic studies relate the occurrence of PVC's to increased risk of sudden death. Chiang and his co-workers from the Tecumseh Prospective Study reported that over a 6 year period the sudden death rate among persons over 30 with PVC's was 6 times that of persons without PVC's. Hinckle and co-workers monitoring actively employed men aged 55, found that the presence of PVC's with a frequency greater than 10 per 1000 cycles identified a group with a tenfold greater risk of cardiac death. Therefore, as soon as the employee has an acute heart attack at work he should be placed on a cardiac monitor and ventricular premature beats should be specifically looked for. Administration of antiarrhythmic drugs, such as Lidocaine, could avert a sudden disaster. Also, many employees actively

working, and who are at high risk, should be placed on antiarrhythmic drugs, especially if they have demonstrated cardiac arrhythmia previously.

Returning the Patient to Work:

Next, I would like to discuss the matter of returning the cardiac patient to his job. Obviously, there is no fixed time interval following an acute myocardial infarction when the cardiac patient should return to his job. There are individual differences in the extent of damage to the heart, plus the more complex matters of the type of job to which he is returning, environmental conditions, social factors, and motivation. Both industry and the medical profession need help in this area. Not enough has been done in the past towards the whole problem of cardiac rehabilitation. Several excellent cardiac evaluation work units have been set up in various cities of the country, and this is a start in the right direction.

Various classifications have been proposed for grading occupational demands. A system based on peak loads has been used and generally corresponds to common conceptions of what is and what is not heavy work. For example, sedentary work entails a peak load of 2.5 calories per minute or below. This means lifting 10 lbs. maximum and occasionally lifting and/or carrying such articles as dockets, ledgers, and small tools. Although a sedentary job is defined as one which involves sitting, a certain amount of walking and standing is often necessary in carrying out job duties. Jobs are sedentary if walking and standing are required only occasionally and other sedentary criteria are met.

Light work implies a peak load of 2.6 to 4.9 calories per minute or in other words it means lifting 20 lbs. maximum with frequent lifting and/or carrying of objects weighing up to 10 lbs. Even though the weight lifted may be only a negligible amount, a job in this category requires standing or walking to a significant degree or it involves sitting most of the time with a degree of pushing or pulling of arms and/or leg controls.

Medium work implies a peak load of 5 to 7.5 calories per minute or "lifting 50 lbs. of maximum with frequent lifting and/or carrying of objects weighing up to 25 lbs."

Heavy work implies a peak load of 7.6 calories per minute and above. There is lifting of 100 lbs. maximum with frequent lifting and/or carrying of objects weighing up to 50 lbs.

Evaluation and classification of each job is based on a definite number of studies, usually after observation of the job and for different places of business. Because of this, some variation is expected. I might add that these definitions were taken from the Dictionary of Occupational Titles, Third Edition, Supplement 2, 1968, U.S. Department of Labor, Washington, D.C.

The restrictions placed on the patient should entail a thorough knowledge of:

1. The demands placed upon the circulatory system by various activities.
2. The present and future functional state of the circulatory system.

3. The acute and long term effects of those demands on the functional state of the circulatory system.

The circulatory system's response to a given level of energy expenditure may be modified greatly by many individual factors including the following:

1. Restricted systemic cardiac output.
2. Duration of work. The duration of work is important. The energy demands during maximal effort lasting less than 2 minutes are largely covered by anaerobic metabolism so performance capacity is not directly related to oxygen uptake and cardiac output. A person with a restricted aerobic capacity can frequently tolerate heavy workloads provided the work is of short duration and is followed by adequate periods of rest and/or work of low intensity.
3. The nature of the work, i.e. isometric or isotonic, significantly affects the circulatory response. It has been well established that isometric work and work with an isometric component such as lifting, holding, or carrying objects of all kinds, pushing heavy objects, or working with arms over head is associated with a much larger increase in systemic blood pressure than isotonic work at a similar level of oxygen uptake.
4. Environment: High altitude for example requires an increased systemic cardiac output to compensate for a lower peripheral arterial oxygen saturation. Extremes in environmental temperatures also require an increased systemic cardiac output. In addition, high altitude may significantly increase pulmonary vascular resistence in patients

with pulmonary hypertension.

5. Emotional Stress: This may produce profound circulatory changes and significantly add to the circulatory load during physical work without affecting level of energy expenditure.
6. Body Size: This should be taken into consideration in any discussion of energy demands. In general, a smaller individual is not at a disadvantage as long as the task primarily consists of locomotion. The energy cost of walking and running is proportional to body weight. By contrast, the energy costs of moving objects is largely independent of body size. The small individual is at a distinct advantage since physical work condition, all other things being equal, is proportional to body weight.
7. Vigorousness of movement.
8. Individual Variation.

Finally, the cardiac who is returned to work should be checked periodically and should be made to feel that the industrial physician is interested in maintaining his health and welfare. The employee should feel free to seek counsel, particularly if he is having symptoms.

One of the better methods of objectively assessing the progress of the cardiac is the use of the bicycle ergometer or treadmill stress test. This is now being used extensively throughout the country to give a better idea of cardiac performance as manifested by heart rate response, blood pressure, and

electrocardiographic changes.

In conclusion, I have tried to discuss a large topic in a short period of time with the hope I have given you an overview of the problem of the employee who may be having premonitory symptoms but who through ignorance, fear, or indecision fails to seek medical attention promptly enough and is heading towards a cardiac disaster. I have tried to emphasize the importance of both public education in this matter as well as professional education. The physician must be able to receive the patient with a prepared plan to reduce sudden death and to obtain speedy and effective care for the patient. Mortality reduction will not be affected without a carefully planned approach entailing some of the principles which I have discussed. It is important that the physician understands the use of a monitoring system which need not be very elaborate, and not too costly, and he must be able to administer antiarrhythmic agents promptly as well as to be able to do cardiac defibrillation, and institute prompt cardiopulmonary resuscitative efforts so that the patient could be kept alive until he is transferred to a hospital for further care. Finally, I have attempted to portray the need for a more diligent effort to return the cardiac patient back to his job in a sensible manner with a rational prescription tailored to his physical and emotional capabilities. The physician will have more confidence in placing the patient back on the job if he understands the type of job to which the patient is returning, the levels of energy expenditure required by that job, the environmental and emotional conditions under which the work must be conducted, and the duration of work requiring maximal energy demands.

INFRASOUND

by

F. G. Pierce, M.D.
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A good many years ago someone asked Albert Einstein if he would give a 30-minute talk on mathematics. His answer was, "Gentlemen, in 30 minutes I couldn't even read the bibliography for such a talk." Today, I do not find myself in that enviable position. Reviewing the literature on infrasound turns out to be somewhat less of a task than a review of the literature on such a subject as "the social life of a cigar butt."

Let us first define infrasound so that at least we will all know what we know nothing about. Infrasound is classified and described as the sound frequency which lies between 2 and 20 cpc or 2-20 hertz. Now that should put you in the driver's seat.

These frequencies are below the capacity of the human ear to hear, but because they produce vibrant energy, they are capable of producing certain effects on humans. These effects, most of which so far are subjective in nature, have been the topic of several research projects.

It would be well at this point to bring out the seriousness of the problem. We have spent vast resources on the effects on man of unclean air, polluted water and high frequency noises - all of which are gradually taking their toll of life or at least producing measurable pathology in the human race. Having reviewed the subject of infrasound, I am convinced that we are on the verge of discovering yet another environmental factor to add to the onslaught. Unfortunately, we have merely tapped the surface of this one. Who can say for example, that the results of some of our studies on hi-frequency sound haven't reflected some affects of infrasound, since many of the studies were done with mixed frequencies.

For the moment, consider the sources of infrasound to which we are all subject: (1) automobiles; (2) airplanes; (3) home air conditioners and heating units, dishwashers, washing machines; (4) trucks; (5) buses, trains, and marine engines, etc. There is hardly an hour in any day that all of us are not subject to exposure to infrasound, much of it in small amounts perhaps, but a steady, constant exposure.

For example, an engineer whom I know recently measured the level of infrasound in his modern automobile while driving on a highway at 50 mph. This so called "quiet" car produced over 100 decibels of infrasound at 2-22 cpc. This was with the car in good operating condition and with the windows closed.

Now consider this. To date no one has outlined or established acceptable precautions of what constitutes excessive chronic exposure to infrasound. The closest we have come to this is the study by Mohr, Cole, Guild, and Von Gierke, which shows that even short term exposures above 150 dcb produces definitely recognizable subjective effects. The studies of Nixon and Sommer have pointed out the effects of infrasound on our ability to communicate. Nixon with Harold Eille have even gone so far as to tury the attenuation effects of ear muffs on infrasound--so we at least have made some inquiries as to how to prevent exposure, but we don't know as yet what we are protecting ourselves from.

For those of you who think you might be interested in this topic, I can highly recommend that you read the translation of an article by Vladimir Gavreau of France, who is the head of the Electro Acoustics and Automation Lab of the National Center of Scientific Research of France. The article appeared in Science Magazine in January of 1968, Pg. 33-37. One of the many points which he brings out is the fact that infrasound is not difficult to measure, indeed, the meterological people have been using infrasound detectors for years to ascertain the location and intensity of thunderstorms, tornados, and hurricanes, all of which produce infrasound emissions measurable for miles. He also points out that infrasonic detectors were being used in World War I to locate enemy guns. So our lack of investigation cannot be excused by any statement to the effect that "our enemy is not measurable."

I shall now enumerate for you the subjective symptoms which have been repeatedly documented by several authors in studies in which they imply that "Any results must be considered as less than conclusive considering that inadequate numbers of subjects and the lack of basic knowledge of the existing problem." Here are the symptoms:

1. Fatigue.
2. Irritability
3. Insomnia
4. Headache
5. Lack of ability to concentrate
6. Loss of equilibrium

All of these symptoms, plus some others, have been as well documented as can be expected in studies designed for subjective results. As we all know, any such studies are always subject to a great deal of questioning by researchers who deal with objective results only. One of our main problems in this sphere is that we have so far not been able to come up with a study of objective findings which can be reproduced and measured in a laboratory.

The most extensive study to date which dealt with measurable components was done by Gragnot of France in which it was related that there appears to be measurable changes in vitamin C, cholesterol and glucose in people subjected to relatively high amounts of infrasound for short periods. Certainly as a future project, these studies should be closely analyzed and repeated by the same method to ascertain whether or not the results are reproducible. Also, since the levels of all three of these substances are constantly in a kinetic mode in the body, one wonders as the authors did if, in truth, infrasound itself was really the cause of the changes or whether the stress produced by infrasound was actually the culprit. Mahr, et al, were not able to reproduce these results using different methods.

Let me now reveal to you some strictly subjective facts which have come to my knowledge. I am not introducing these facts as gospel, only mentioning them as food for thought.

1. Why is it that in a building in which the infrasound level has been measured to be in excess of 80 dcb, has there been a two and one-half times turnover of personnel over a period of three years? It may mean nothing - but it is worth mentioning.

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1. Why is it that in a building in which the infrasound level has been measured to be in excess of 80 dcb, has there been a two and one-half times turnover of personnel over a period of three years? It may mean nothing - but it is worth mentioning.

2. Why is it that several members of top supervision of this particular building have come to me independently complaining of fatigue, irritability, headache, and inability to concentrate? It may mean nothing, but it is worth mentioning.

3. Why is it that airline pilots and truck drivers have gone to their management and unions to complain about excessive fatigue and inability to concentrate on longer trips? Maybe there was an ulterior motive; maybe there is a true physiological reason. I think we should start as soon as possible.

NASA has spent no small amount of time and effort studying the whole problem of infrasound in their spacecraft in addition to higher intensity sound. I feel we, as a group, should help in any way we can to add to the meager amount of knowledge now available. I foresee that in the not-too-distant future, the automotive industry--spurred on perhaps by some Naderian influence--will begin to research in this area, to be followed closely by airlines, textile fibers, boiler makers, etc. I would like history to show that we, as a group, added substantially to early knowledge of the problem.

What we need, and need now, is a reproducible, measurable effect on humans of infrasound energy exposure. At Kennedy Space Center we are interested in a study of the effects of infrasound on the fragility of red blood cells. We are also thinking of a study on the learning curve of rats, not as objective a project as others, but it might tell us something. A study on the effects of infrasound on serum proteins

might also prove enlightening. Certainly, any work directed toward the central nervous system would be most interesting. We must obtain some measurable, repeatable information. (As is the usual case in medical research.) Subjective clinical symptoms have given us our first hint; we must now go into the organized research phase of the problem with the air of establishing reasonable T.L.V.'s for chronic and acute exposure.

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SILENT INFRASOUND POSES THREAT TO HUMAN BODY (Today)

PHYSIOPATHOLOGICAL REACTIONS OF THE HUMAN BEING EXPOSED TO INFRASOUNDS VIA THE AURICULAR CANAL (P. Grognot)

INFRASOUND V. Gavreau (Science/Jan. 1968)

THE MANAGEMENT OF CHRONIC DISEASE:

A STUDY OF EMPLOYEE MORBIDITY AND MORTALITY at the NASA GODDARD SPACE FLIGHT CENTER 1966-1971

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The purpose of this paper is to present several approaches to the study of chronic disease in an employee population. The data presented are very preliminary, therefore, no conclusions of any kind should be drawn from their use. We are now preparing another study on this subject with the use of more definitive data from which valid conclusions may be reached.

The evolution of chronic disease in a skilled, trained, productive, workforce is a subject of major concern to an organization. While in the long term, no single individual may be considered indispensable or his absence, temporary or permanent, detrimental to the good of the whole, the loss of his services does present immediate problems in recycling his workload, assigning others his duties, and should his loss be permanent, a major expense in recruitment and retraining his successor. When such losses occur in a large number of workers, or within a short period of time, they may actually interrupt production schedules and deadlines and thus ultimately affect the entire organization in its ability to meet the commitments to which it is dedicated.

In 1970, at the NASA Goddard Space Flight Center, a population of approximately 4,000 workers, there were 13 fatal and 102 non-fatal major time loss episodes, caused by mental disorders, diseases of the circulatory and digestive systems, and neoplasms. Based on the average annual salary rate for 1970, the total personnel resource loss due to chronic disease, was over a quarter of a million dollars.

A review of employee health records over the past five and a half years produces two facts worthy of consideration:

in a dynamic working population, chronic disease rates do not remain constant (Figure 1), nor are they distributed evenly throughout the organization (Figure 2). If a preventive medicine program, operating within the organizational environment is to achieve its objective, that of promoting the health and well-being of the employee population, and is given limited and probably less than adequate resources to do its job, it should be aware of trends and patterns in disease prevalence, be able to separate high risk groups from those with low risk of disease, and search for possible contributory employment-related problems and conditions.

In this paper we will review the chronic disease incidence experience at Goddard, during the period from 1966 to 1970, summarize preliminary data for 1971, and attempt to relate this experience to specific programs and events which may have had some causative influence. The information used will include records of periodic and return to work examinations conducted by the Goddard medical facility, injury and illness visit reports, and mortality data.

The Relationship Between Major and Minor Disease States

First, it is proper to consider the relationship between minor disease states, major disease states, and permanent disability

and mortality. Although Figure 1 deals totally with major illness episodes, even these may be ranked by order of debility, with mental and digestive disorders (usually causing temporary time loss and rarely death) at the bottom, diseases of the circulatory system and neoplasms (which may be permanently disabling, and perhaps fatal) in the middle, and mortalities (representing permanent severance from the organization) at the top. As episode rates in the lesser conditions increase, so do the rates for the more serious illnesses, and mortalities. A graphic display of these relationships appears in Figure 3.

It is quite logical that a population yielding an increasing rate of non-fatal chronic disease states, such as in circulatory disease, and neoplasms (and thus weakened by the first onset of these conditions) might also yield an increasing rate of mortalities from the same diseases. It is also logical to assume that if these diseases are influenced by certain changes or stresses in the environment, these stresses may first be expressed in a population in the form of sub-clinical symptoms and behavioral patterns, then in the development of overt conditions such as anxiety neuroses and various digestive disorders, and finally in more serious diseases and conditions which may ultimately cause permanent disability or even death.

At Goddard, there has been a rising trend in all categories of diseases, which is explained neither by changes in the overall composition of the population, nor by aging (Figure 4).

The Relationship Between Disease and the Internal Organizational Environment

If the onset of chronic disease is produced or at least aggravated by conditions of the occupational, social, or economic environment, the preventive medicine team should be aware of these influences and their relationship to their patients' health. Environmental conditions may be divided into two categories, those created soleiy within the organization and unique to it, and those created by the outside world. We shall deal first with conditions of the internal environment.

In Figure 2, the distribution of chronic disease incidence by organizational element, we found significant differences in all categories. Since these might have been accounted for by differences in the occupational composition and age of the population, we selected four organizational units for detailed study. In the following discussion, the analvses pertain only to male employees, and only to those who were working at Goddard at the beginning and at the end of the study period (1966 to 1971), or who had been separated during the period for medical disability or death.

The first two groups are the Tracking and Data Systems Directorate (Code 500), responsible for data acquisition and analysis in the operation of the unmanned satellite tracking network, and the Manned Flight Support Directorate (Code 800), responsible for data acquisition and analysis in the operation of the manned flight tracking network. The male population of both directorates is composed essentially of engineers and technicians, and there is no significant difference in age. In 1966, the two populations were combined in a single unit. In 1967, because of the emphasis on the manned lunar landing program, the unit was split and the two separate directorates were formed.

The five year history of coronary heart disease and malignant neoplasm fatal and non-fatal episodes is shown in Figure 5. In summary, the male population in Code 500 sustained a rate of 37 per 10,000 and Code 800, a rate of 110 per 10,000, a significant difference ($P = .01$).

The second two groups are the Projects Directorate (Code 400) and the Space and Earth Sciences Directorate (Code 600). The male population of Code 400 is composed mainly of engineers and technicians involved in the development and design of unmanned scientific satellites. Code 600 is populated predominantly with

scientists and scientific aides, and is engaged in long term research and theoretical studies. Again, there is no significant difference in age.

The five year history of major chronic disease episodes for these two directorates is shown in Figure 6. Here, there was also a significant difference between a total rate of 51 per 10,000 in Code 600 and a rate of 151 per 10,000 in Code 400 (P= .05).

A second form of data, and certainly more important for our purposes, would be a means of detecting high stress periods through discreet clinical measurements before actual disease conditions evolve. In an occupational environment, where we take routine periodic measurements of large segments of the population over long periods of time, this may be possible.

As an example, using our same four directorates, we have plotted a moving average of the mean diastolic blood pressure in male employees, age 40 to 49, over the five year period. The results appear in Figures 7 and 8. In both cases, there are long periods (those in which the majority of the illness episodes occurred), in which the means of the high risk groups exceed those of the low risk, and at least support, in part, the logic of being able to isolate critical periods of time and populations, not only by disease trends, but by other measures.

In Figures 9 and 10, the same mean diastolic blood pressures are plotted against the disease trends for Codes 800 and 400. The patterns for both organizations are remarkably similar, with the upward trends in blood pressure occurring well before the upward trends in disease, and suggesting that some predictive capability may exist. Again, these figures are based on only one of a multitude of measurements and certainly others may serve us as well as epidemiological indictors.

Space flight activities are recorded above the blood pressure trend lines. In Code 800 the peak mean blood pressures are reached during the period between the first lunar orbit and the first two manned landings. In Code 400, the peak is reached during late 1968 and 1969 with the unmanned launch activity was heaviest.

One can hypothesize quite readily about the reasons for the differences among the selected groups. More stress, and thus illness, would appear to be associated with monitoring a manned space probe than with an unmanned probe. Similarly, the direction of specific flight projects with fixed deadlines appears to be more injurious to health than the slower paced environment of the space scientist. However, to assign the cause of ill health to any single occupational factor, is erroneous, and ignores the important external

influences of heredity and the socio-economic environment. Here, we are concerned, not really with causes, but more with methods of detecting and monitoring high risk populations, and for this purpose disease trends seem to have some practicality.

The Relationship Between Disease and the External Environment

In 1966 NASA had reached its peak. From that year began a progressive decline in federal funding, manpower, and space flight activities, summarized in Figure 11. Of the major NASA installations, Goddard was the only facility which continued to grow.

From mid-year 1967 to the end of 1970 the NASA population had been reduced by 5,500 workers. This was accomplished by normal attrition, voluntary retirements, and by reductions in force (RIF). The diminished space exploration effort affected industry as well as NASA and suddenly aerospace employees who had been accustomed to widespread mobility and a seemingly endless choice of jobs were faced with employment freezes and layoffs.

As other NASA facilities reduced their populations, some of the unemployed were absorbed by Goddard. The Goddard employees, though still secure in their own environment, could not have been unaware of events outside, and if they doubted the accounts in their daily newspapers, they now had first hand accounts from their relocated fellow employees.

As the aerospace program has declined it has uniquely affected both the highly skilled employees and the unskilled. Traditionally, non-professional workers have been considered more insecure in declining employment situations than professionals. If this is true, it may partially explain the sudden increase in employee mortality at Goddard shown in Figure 12, culminating in a significant difference between the two groups in January 1971, when the first Goddard reduction in force was announced.

At Goddard, the majority of the non-professional workers reside in the Directorate of Administration and Management (Code 200). In Figure 13, we have a summary of acute episodes for that Directorate. In the twelve month period centered in January 1969, the total episode rate was 172.4 per 10,000. In the twelve month period centered in January 1971, the month of the RIF announcement, the rate was 322.6, a significant increase.

Although the reduction in force was officially announced in January, it was not accomplished until eight months later in August, 1971. The period was one of uncertainty, not only for those employees who would actually be affected, but for the whole population. The immediate effects were a dramatic increase in medical facility visits. In Figure 14, we have the trend for the twenty month period beginning in January 1970, for Code 200. From the date of the

RIF announcement, non-occupational visits increased steadily until May, the month of the voluntary retirement deadline. Occupational injuries, following their usual upward summer trend, exceeded the peak of the previous summer.

Goddard has passed now from the first phase of total uncertainty, to the transition period, when the new job assignments and relocations are being effected. Beginning in October, the population will enter a third phase, that of adjustment. The full effects of the RIF on employee health will not be seen for possibly another year. In Figure 15, we have again plotted mean diastolic blood pressure against the acute episode rate for Code 200. In the twenty month period under study, blood pressures peaked in January, declined and peaked again following the voluntary retirement deadline, and are now in a second decline. Whether this is significant or not, must await the final data on disease rates.

Summary

The association of environment with the evolution of chronic disease has been a subject of deep concern to the medical community for the past century. The concept of the organizational medical facility opens up a vast new world of possibilities for research in

this area. The discussion here has dealt not particularly with the effects of environment, but rather with the measurement of health trends, with or without external influences. The practicality of such measurements, we feel has been demonstrated, not so much for purposes of research into the essential causes of illness, but in illuminating high risk areas, as an aide in concentrating scarce medical resources where they will have the greatest value. With the growth of automated data systems in the coming decade, the possibilities for real time monitoring of health trends are endless. With this capability, it is hoped that a significant contribution will ultimately be made to the management of chronic disease problems.

NASA GODDARD SPACE FLIGHT CENTER
INCIDENCE OF MAJOR CHRONIC DISEASE, 1966-1970
Rate Per 10,000

	1966	1967	1968	1969	1970
MORTALITIES, ALL CAUSES	20.2	20.0	19.6	30.3	31.2
			NS		
CIRCULATORY DISEASE[1]	60.6	78.1	49.0	98.0	89.3
			S P = .01		
NEOPLASMS[1]	25.3	20.0	27.0	41.8	42.4
		NS P = .07			
MENTAL DISEASE[1]	22.7	22.5	36.8	44.2	49.0
		S P = .05			
DIGESTIVE DISEASE[1]	32.9	62.5	90.9	102.0	78.1
	S P = .001				

1. Includes Fatal and Non-fatal Episodes

FIGURE 1

NASA GODDARD SPACE FLIGHT CENTER

INCIDENCE OF MAJOR CHRONIC DISEASE, BY ORGANIZATION, 1966-1970

Rate Per 10,000

	ORGANIZATION CODE 200	300	400	500	600	700	800	LEVEL OF CONFIDENCE
MORTALITIES, ALL CAUSES	33.1	7.5	42.4	7.1	17.3	36.8	44.8	S P = .05
CIRCULATORY DISEASE[1]	117.6	60.2	63.7	52.1	12.8	53.2	22.4	S P = .001
NEOPLASMS[1]	48.8	15.0	10.6	14.1	13.0	24.4	11.2	S P = .01
MENTAL DISEASE[1]	69.9	7.5	42.4	14.1	25.9	27.5	11.2	S P = .001
DIGESTIVE DISEASE[1]	133.3	90.9	42.4	47.2	38.9	70.4	50.5	S P = .001

1. Includes Fatal and Non-fatal Episodes

FIGURE 2

NASA GODDARD SPACE FLIGHT CENTER
DIGESTIVE, MENTAL, AND CIRCULATORY DISEASE NON-FATAL EPISODES
AND TOTAL DEATHS
Rate Per 10,000
(12 Month Moving Average)

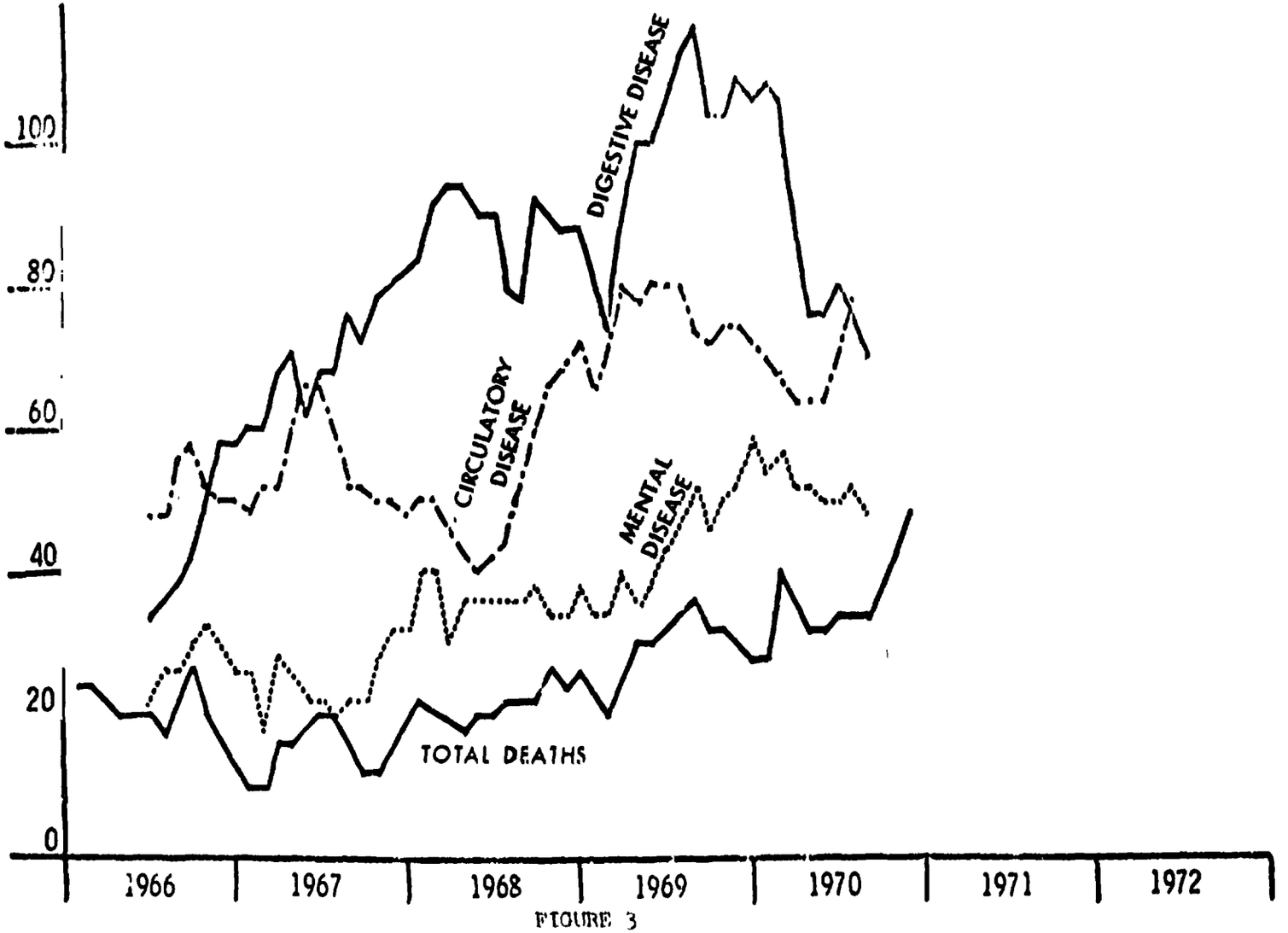

FIGURE 3

NASA GODDARD SPACE FLIGHT CENTER
POPULATION COMPOSITION AND CHANGE, 1966-1970

	1966	1967	1968	1969	1970
POPULATION N	3958	3997	4073	4295	4487
MEAN AGE	38.5	38.2	38.3	38.4	39.0
OCCUPATIONAL COMPOSITION (%)					
TRADES, CRAFTS, TECHNICIANS	21.3	20.9	20.5	24.8	26.5
SCIENTISTS, ENGINEERS	46.0	46.9	48.5	46.3	44.3
SECRETARIAL, CLERICAL	18.5	17.8	16.5	14.7	15.0
PROFESSIONAL MANAGERS	14.2	14.3	14.4	14.2	14.1

FIGURE 4

NASA GODDARD SPACE FLIGHT CENTER
EMPLOYEE MORBIDITY AND MORTALITY EPISODES
1966-1970
MALE EMPLOYEES
(12 Month Moving Average)

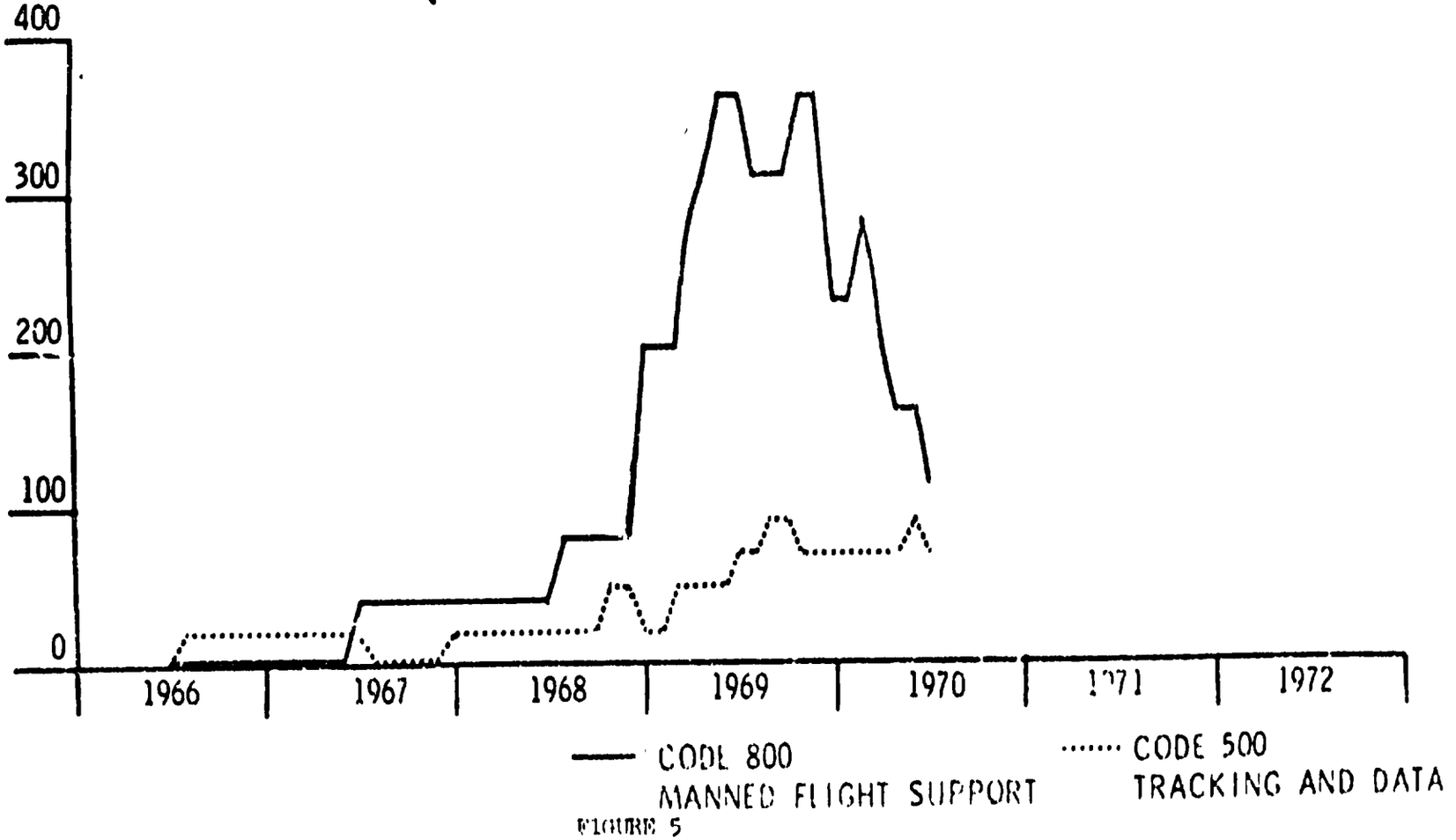

FIGURE 5

NASA GODDARD SPACE FLIGHT CENTER
EMPLOYEE MORBIDITY AND MORTALITY EPISODES
1966-1970
MALE EMPLOYEES
(12 Month Moving Average)

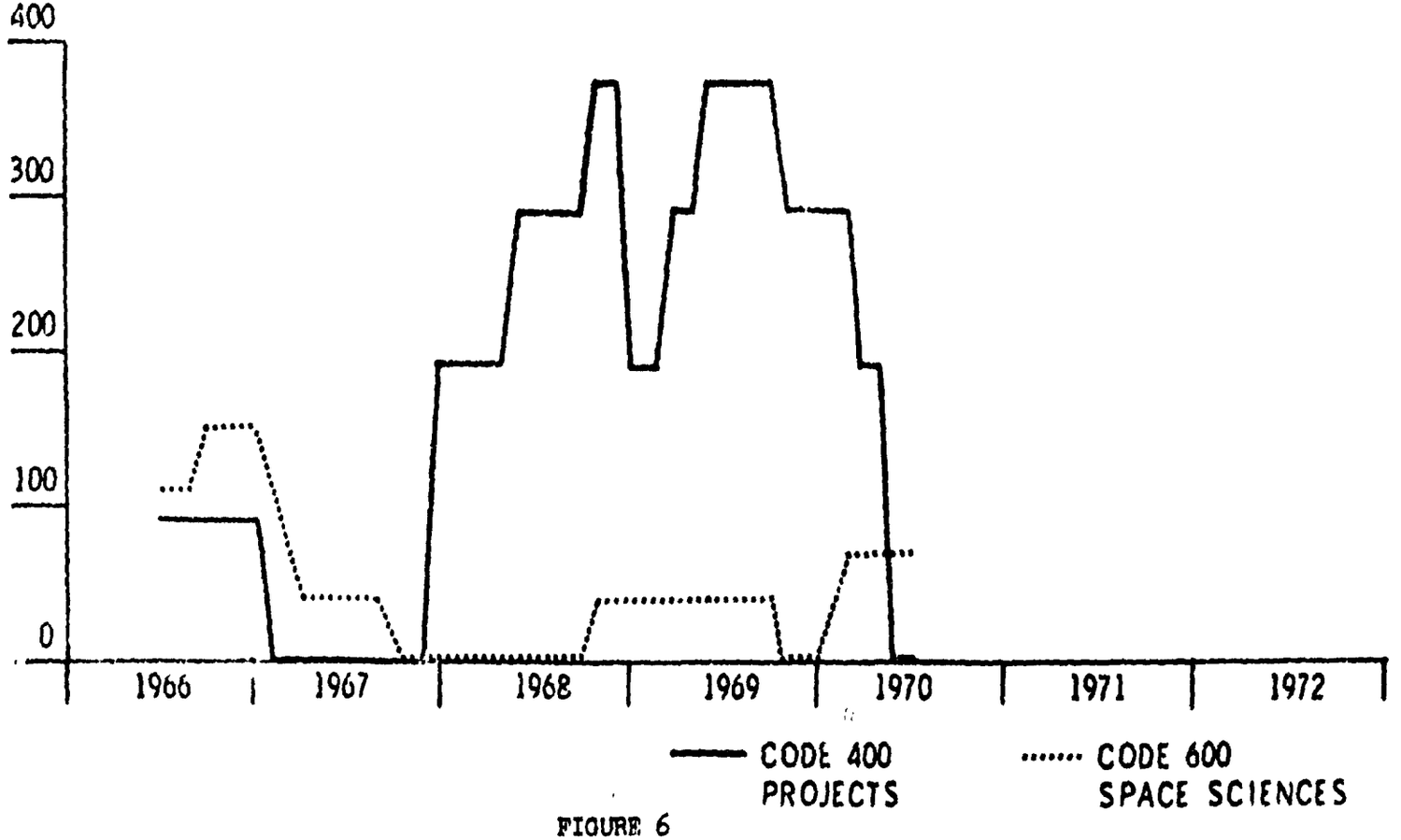

FIGURE 6

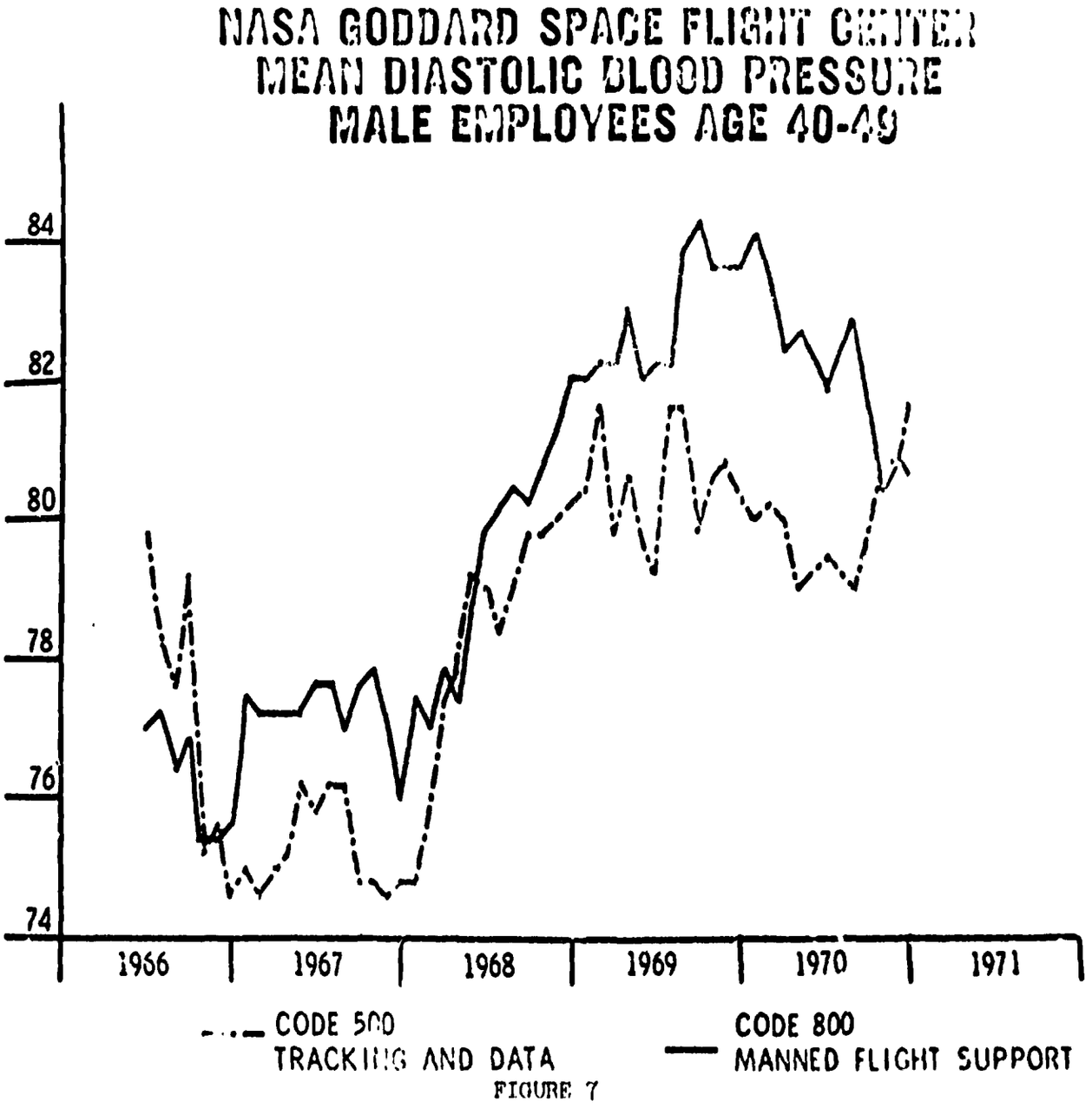
NASA GODDARD SPACE FLIGHT CENTER
MEAN DIASTOLIC BLOOD PRESSURE
MALE EMPLOYEES AGE 40-49
84
82
80
78
76
74
1966
1967
1968
1969
1970
1971
CODE 500
TRACKING AND DATA
CODE 800
MANNED FLIGHT SUPPORT

FIGURE 7

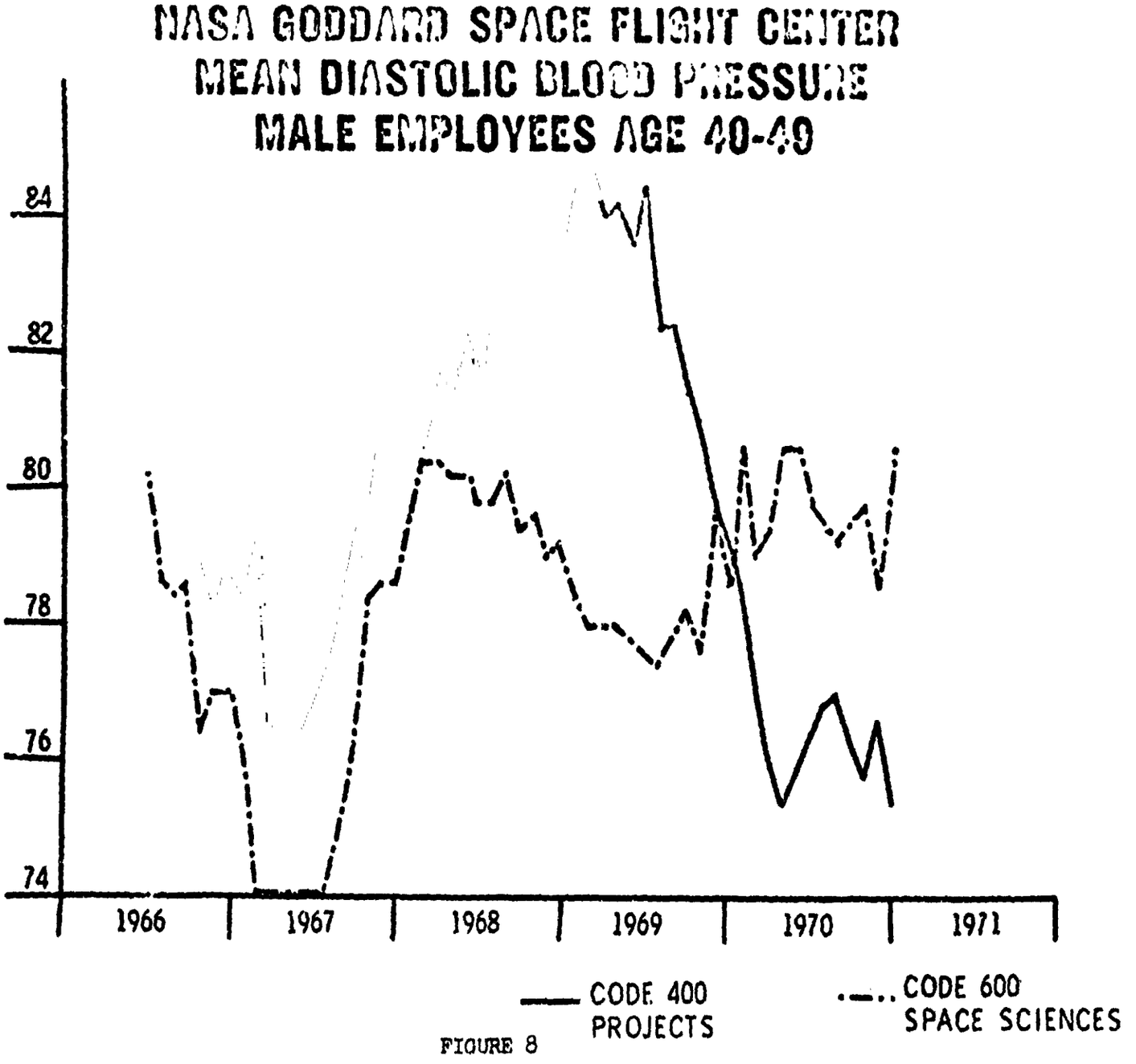
NASA GODDARD SPACE FLIGHT CENTER
MEAN DIASTOLIC BLOOD PRESSURE
MALE EMPLOYEES AGE 40-49
84
82
80
78
76
74
1966
1967
1968
1969
1970
1971
CODE 400
PROJECTS
CODE 600
SPACE SCIENCES

FIGURE 8

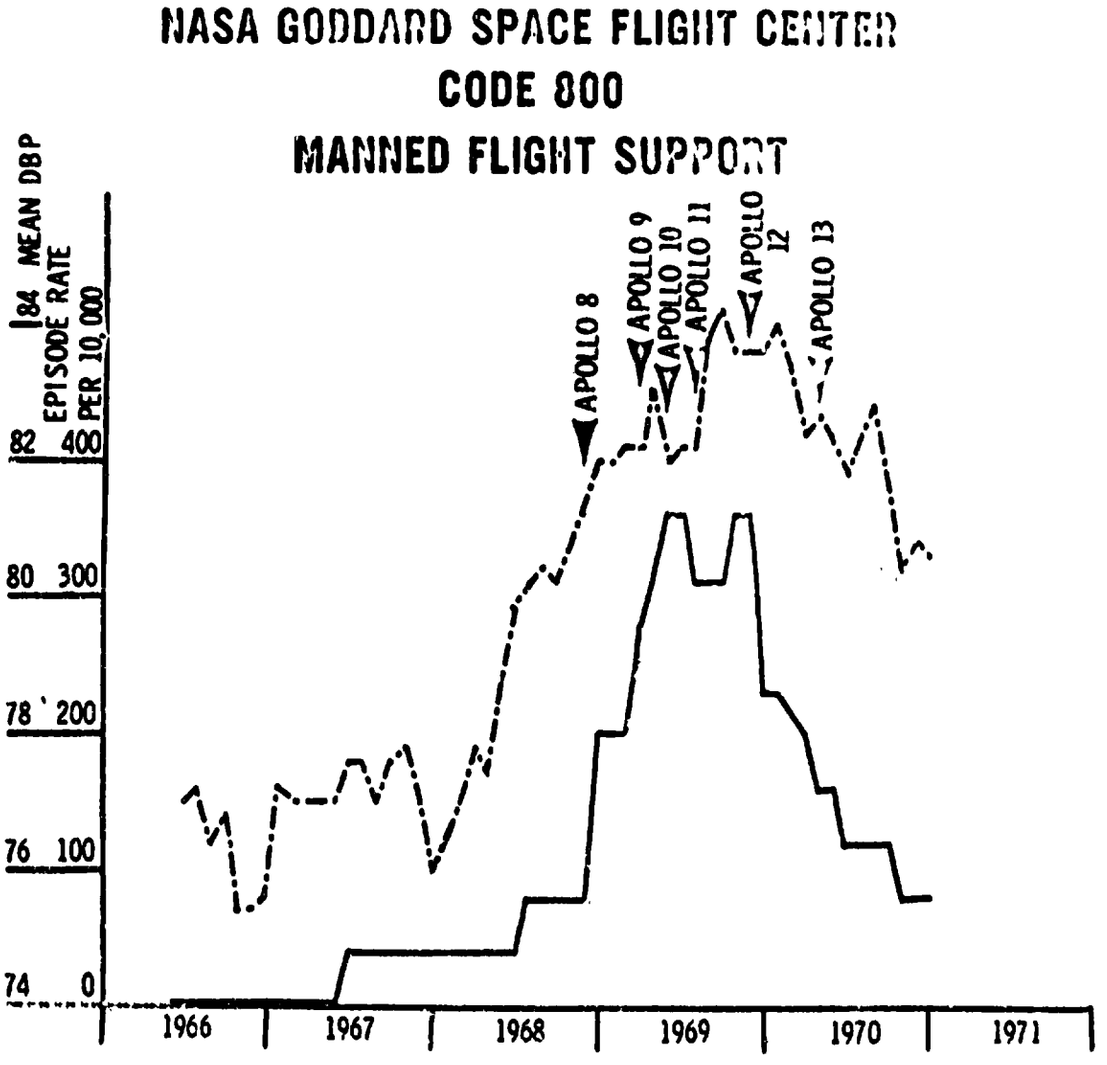
NASA GODDARD SPACE FLIGHT CENTER
CODE 800
MANNED FLIGHT SUPPORT
84 MEAN DBP
EPISODE RATE PER 10,000
82 400
80 300
78 200
76 100
74 0
APOLLO 8
APOLLO 9
APOLLO 10
APOLLO 11
APOLLO 12
APOLLO 13
1966
1967
1968
1969
1970
1971
EMPLOYEE MORBIDITY AND MORTALITY RATE PER 10,000
MEAN DIASTOLIC BLOOD PRESSURE MALE EMPLOYEES AGE 40-49

FIGURE 9

NASA GODDARD SPACE FLIGHT CENTER
CODE 400
PROJECTS

FIGURE 10

STATUS OF NASA FUNDING, MANPOWER, AND SPACE FLIGHT ACTIVITIES

FISCAL YEAR	1966	1967	1968	1969	1970	1971 [1]
NASA APPROPRIATIONS (In Billions of Dollars)	5.2	5.0	4.6	4.0	3.7	3.3
NASA ON-BOARD EMPLOYEES (In Thousands)	35.7	35.9	34.6	33.9	32.6	30.4
MAJOR LAUNCHES [2]	10	1	4	4	1	
MANNED SPACE FLIGHT	18	20	12	12	5	
SPACE SCIENCES	1	1	2	0	3	
ADVANCED RESEARCH						

1. Mid-year
2. Excludes Non-NASA missions

FIGURE 11

NASA GODDARD SPACE FLIGHT CENTER EXPERIENCE
MORTALITIES RATE PER 10,000
(12 Month Moving Average)

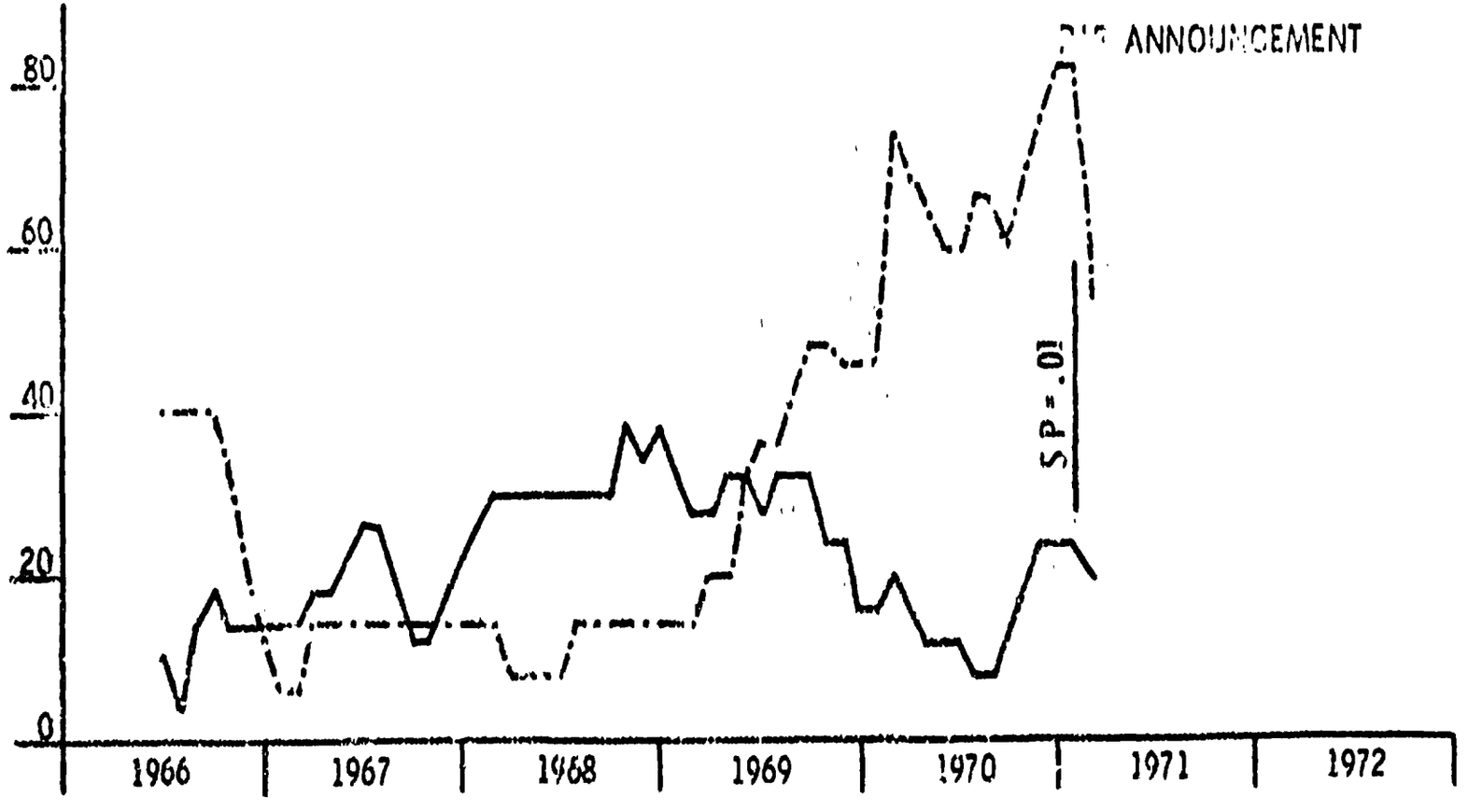

FIGURE 12

NASA GODDARD SPACE FLIGHT CENTER
ACUTE EPISODE RATE PER 10,000
(12 Month Moving Average)

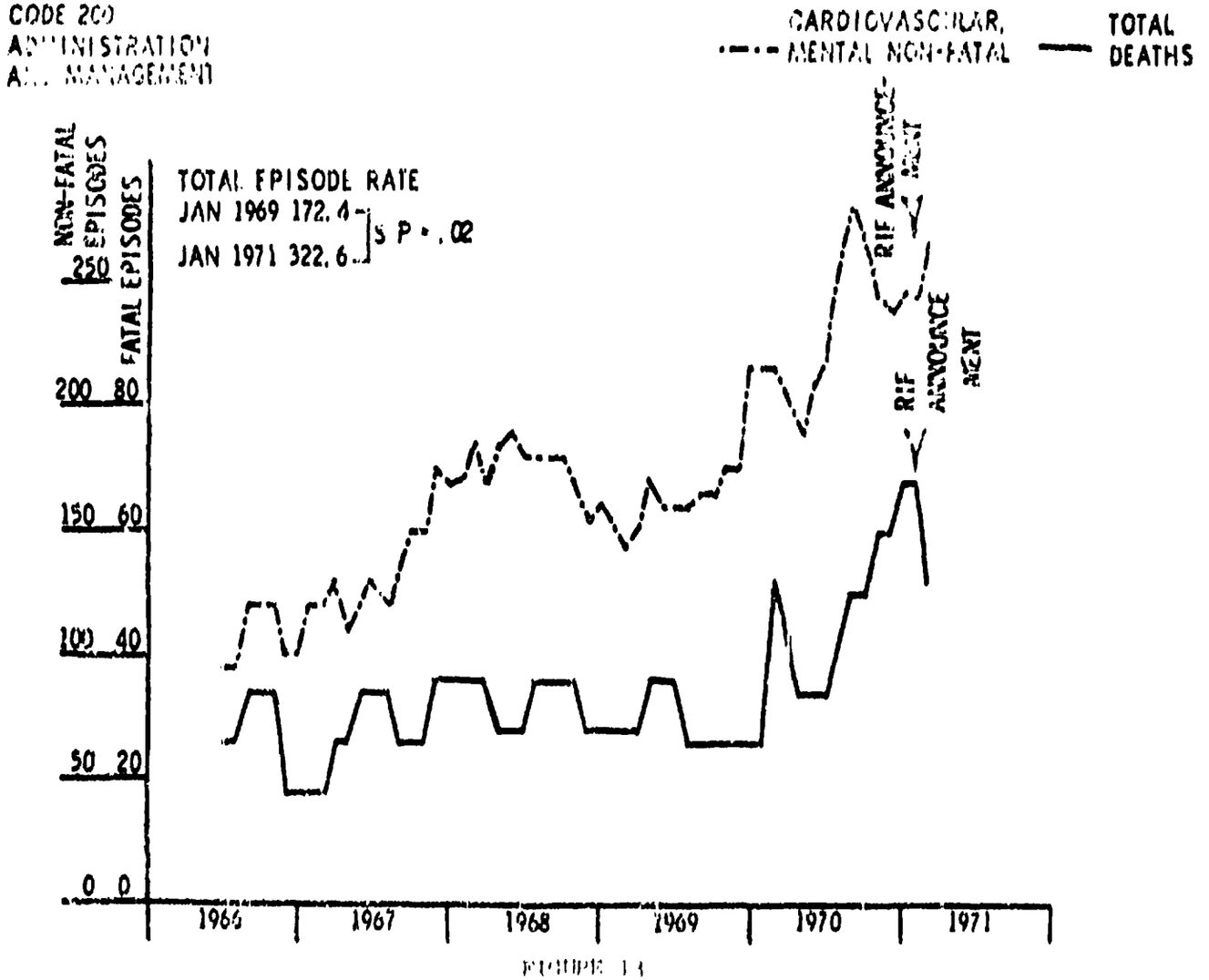

FIGURE 13

NASA GODDARD SPACE FLIGHT CENTER
CODE 200
ADMINISTRATION AND MANAGEMENT

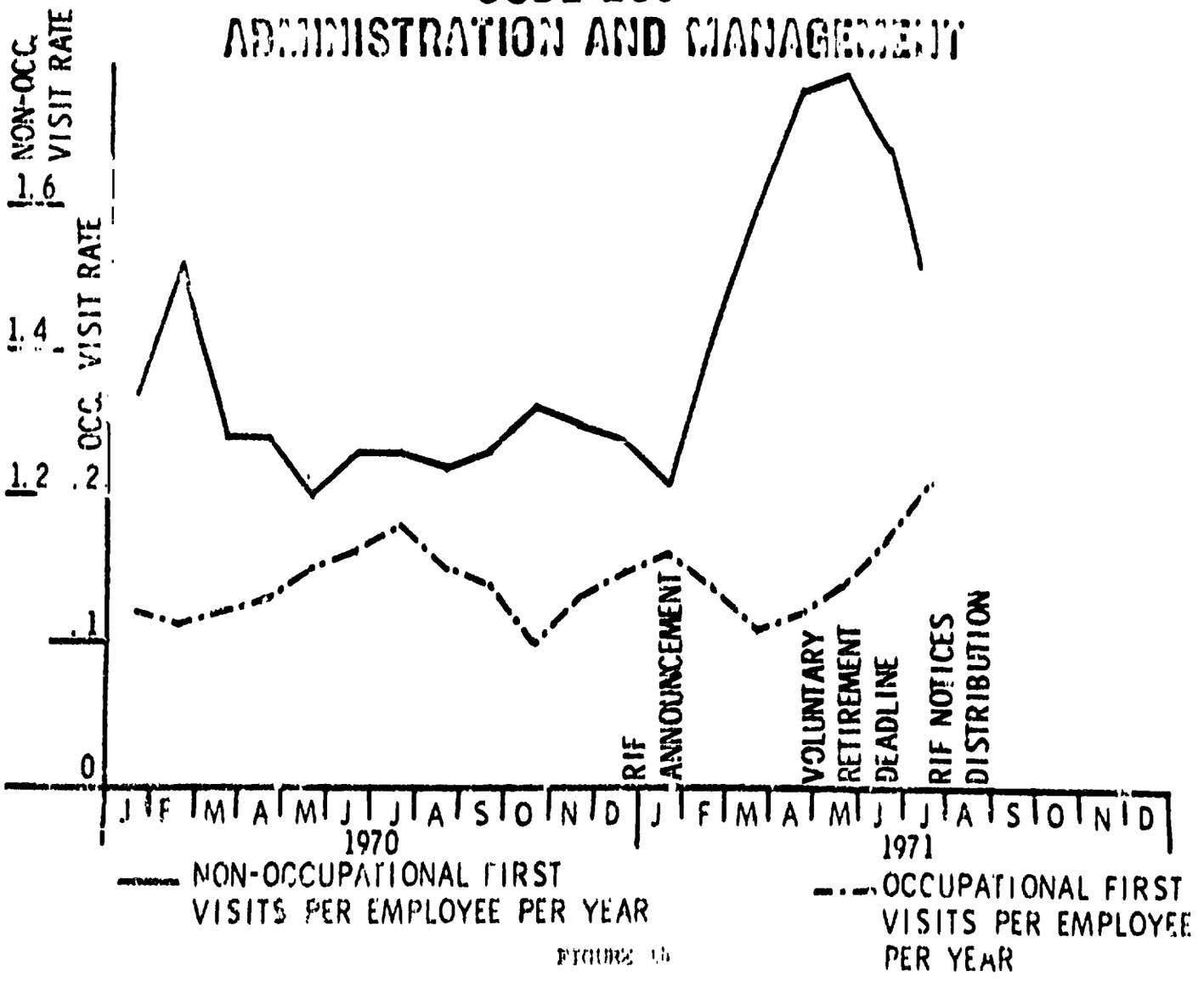

FIGURE 16

NASA GODDARD SPACE FLIGHT CENTER
CODE 200
ADMINISTRATION AND MANAGEMENT

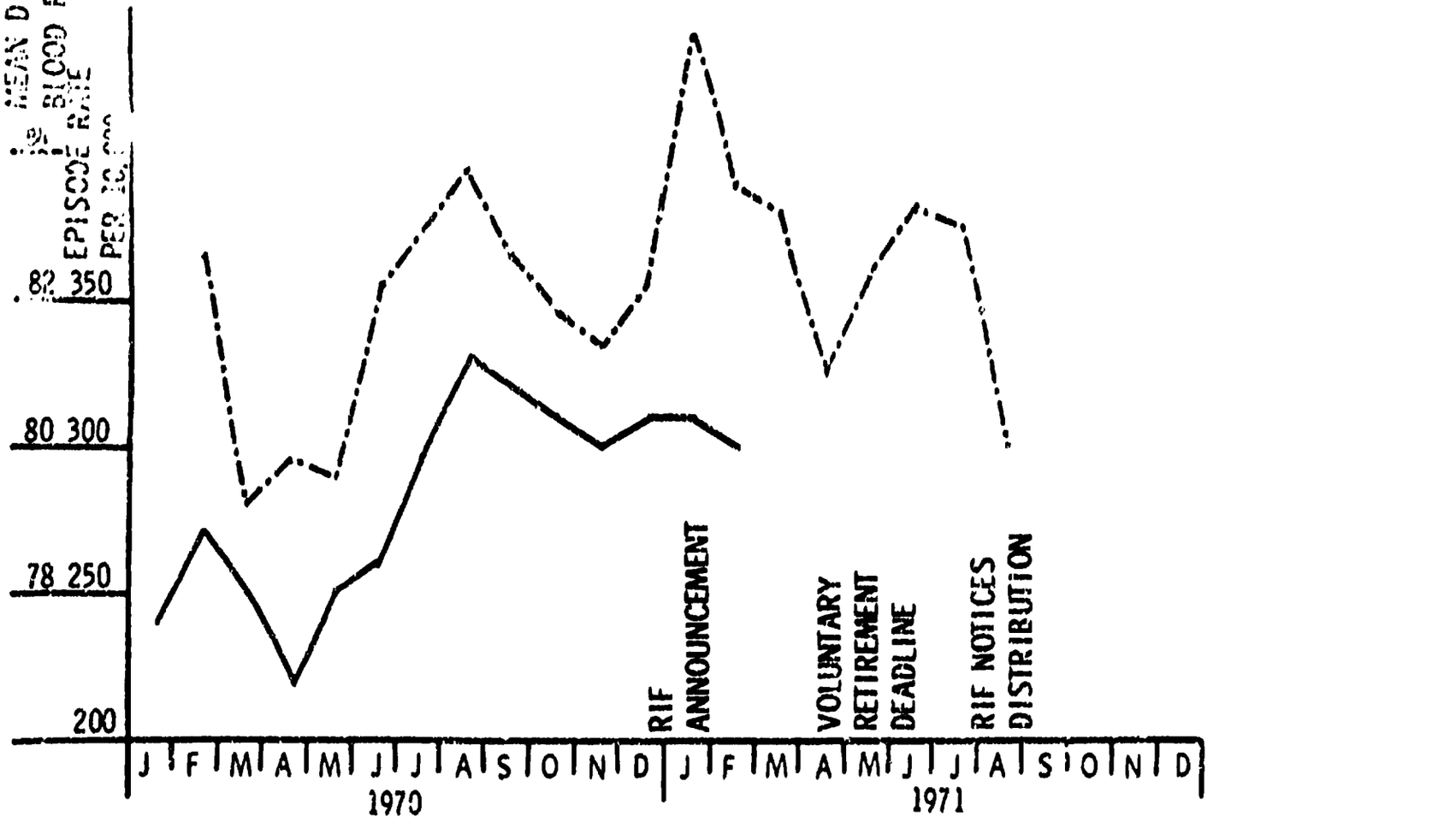

FIGURE 15

AUTOMATION OF THE PROBLEM-ORIENTED MEDICAL RECORD

by

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BRUNSWICK NAVAL AIR STATION
BRUNSWICK, MAINE

Our project is aimed at the development of an improved ambulatory care delivery system for the Navy. It centers around the concepts of the Problem Oriented Medical Record and the expanded use of paramedical personnel.

It was stimulated by the following findings in a study of our own records:

We screened 300 charts of adult dependent and retired personnel. We were searching for the frequency with which the indexes of morbidity and mortality were being checked. The results were pretty discouraging but I am sure are comparable to other clinics. (Slide)

We found only 18% of our records contained a complete history, 10% a complete physical. Only 57% of patients over 40 had a BP recorded, 16% had tonometry and 37% had an EOG.

We also looked to see if doctors got the studies they intended. We selected all charts in this group that had the diagnosis of hypertension. (Slide)

20% had an IVP
33% had an ECG
0 had VMA
20% had BUN

Although these are the studies our doctors told us they got routinely.

The implementation of the Problem Oriented Medical Record is assisting considerably in correcting these problems. I'd like to spend a minute first describing the Problem Oriented Medical Record. (Slide)

This concept was developed by Dr. Lawrence Weed currently at the University of Vermont. Its beauty is in its logic and simplicity. This

slide outlines the medical record. It consists of a Data-Base, from which the Problem Index list is developed. For each problem a plan of management is stated, and then the progress note is indexed to the problem list. (Slide)

The data base is the minimum information which you obtain on every patient in the delivery system. It may be anything you desire but it must be defined. It may be no more than age and sex or the most elaborate multiphasic screen. We use the data base as a multiphasic screen for diseases of high incidence or morbidity.

The formulation of the Problem List is done by a physician acting on information in the data base or on subsequent data. It is a statement of the objective level of diagnosis of a particular problem . (Slide)

It may be a symptom - headache

It may be a lab value - BUN 25

It may be a physical finding - urticaria

It may be a physiologic diagnosis - congestive heart failure

Or it may be an etiologic diagnosis - ASCVD - atrial fibrillation - angina pectoris class III-C.

It must be a statement of fact, and not a calculated guess no matter how brilliant the diagnostician is or thinks he may be. For the diagnosis of diabetes made by the professor of medicine may be 90% accurate and that by the third year medical student only 60%, but neither is 100%. When kept on the objective level, every person approaching that record knows exactly where we stand and knows it quickly. The next person to review the chart will not be led to assumptions that are inaccurate, and compound the errors already made. (Slide)

The formulation of a plan is a concise statement of what the future work-up will be. The plan is generally outlined by lab tests desired, medications and diet, and comment. It is also the final statement of each progress note.

The progress note is then numbered and titled to the problem index list and thus all notes on any problem can easily be identified.

As one treats the patient, he may either deal with one problem: as a specialist in consultation would, or he may deal with them all. He must always be aware of the patient as a whole and can better anticipate the outcome of his therapy. For example, the patient with arthritis who also has dyspeptic symptoms as a problem.

Now I would like to outline our set-up at the Naval Air Station, Brunswick. Our Outpatient dispensary is divided into two areas. (Slide)

1. OPD
2. PPCC Programmed Patient Care Clinic

In the first area the standard operation of a clinic are carried out. This is also the area where the follow-up from the data base takes place.

The second area is our Programmed Patient Care Clinic. In this area all well baby, juvenile physicals, and adult data base examinations are carried out.

An adult entering into care in our clinic is referred for routine examination to the PPCC. Our Data Base consists of: (Slide)

Interactive automated history at a cost of approximately $2.50, EKG, chest X-ray, spirometry, audiometry, tonometry, Hct, BUN, cholesterol,

urine sugar and acetone, 1 hr. post load glucose, serology, and routine physical exam excluding heart, breast, and pelvic. This is all done by two corpsmen and one medical assistant. They handle patients at the rate of 15 per day. The cost of our data base has been independently estimated at $22.00. The patient spends approximately 45 minutes taking the history and another 45 minutes for the rest of the examination.

Seventy-eight percent of our population felt that the data base was a significant improvement in the quality of their medical care.

Only limitation in our ability to find the appropriate girl has prevented us from adding the PAP and pelvic to the data base. It is currently done by the physician in the follow-up exam. However, when we posed the following question to our patients (Slide) we got these results: 84-1/2% would not object to this study done by a paramedic.

Our follow-up exam, as it currently stands, with the establishment of a problem list, takes approximately 20-40 minutes. Our first year follow-up study of 600 cases showed that 47.2% had new diseases picked up by the data base.

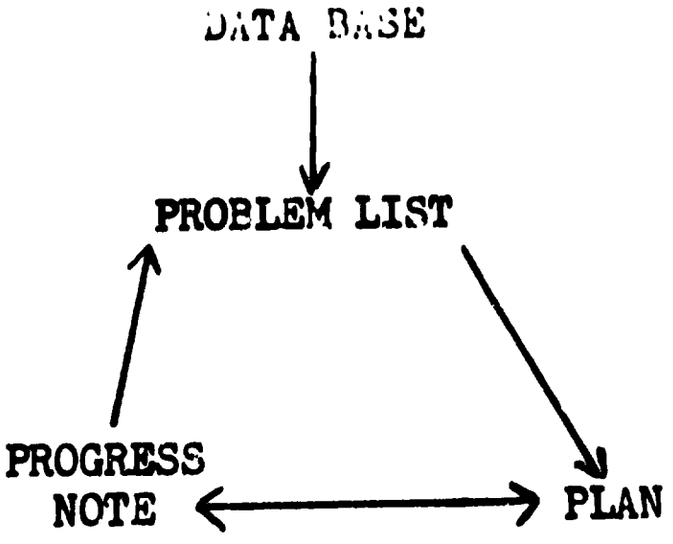
Once the record is structured in this fashion automation is a simple task of application. We are now converting to a completely computerized medical record.

Upon following up the data base the physician dictates his problem list and a plan on each patient. On subsequent visits identification of the patient produces the problem list. (Slide)

When the physician selects a particular problem the notes are reproduced in reverse chronological order. (Slide) The lab reports are cross-filed into the notes at the point where ordered and into flow sheets.

The current note is dictated and added to the record. (Slide) The files may be searched for a diagnosis, for a medication, by particular physicians. The record may be reprinted for mailing or sent electronically to any other area where the patient might be cared for.

This system is not a panacia to medicine. It will not deliver any medical care - good or bad. It will not prevent poor judgment if it is used. But it will function to identify all the patient's problems, its structure and legibility will permit busy doctors to rapidly identify what is going on and to evaluate what should be done next. In this respect, it has proven to be an extremely useful tool.


DATA BASE
PROBLEM LIST
PROGRESS NOTE
PLAN

DATA BASE

1. MUST BE DEFINED

2. MUST BE CONSISTANT

3. MAY BE DONE COMPLETELY BY AUTOMATED METHODS AND PARAMEDICAL PERSONNEL

PROBLEM LIST

SYMPTOMATIC PROBLEM - HEADACHE

LABORATORY PROBLEM - BUN 26

PHYSICAL FINDING - URTICARIA

PHYSIOLOGIC PROBLEM - CONGESTIVE HEART FAILURE

ETIOLOGIC DIAGNOSIS - ASCVD - ATRIAL FIBRILLATION
ANGINA PECTORIS CLASS III-C

PROGRESS NOTE

NO. & TITLE

SUBJ.

OBJ.

PLAN - LAB.

MED.

COMMENT

A CASE OF NEAR FATAL AMMONIA GAS POISONING

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Wallops Island, Virginia

This paper is a report of a near fatal accident, caused by the exposure of an employee to an environment of approximately 100% anhydrous ammonia for a period of about five minutes. On December 11, 1969, while working with the cooling system in the compression room, C.I., a 20-year-old healthy white male, accidently bested the ammonia line in the refrigeration unit, causing the anhydrous liquid ammonia to escape from the safety valve, and fill the room with ammonia vapors.

C. I. was found lying unconscious with his safety mask off on the floor of the compression room by his supervisor approximately five minutes later. He was dragged from the room by the supervisor and the plant nurse was promptly called. She summoned an ambulance, and on arrival of the ambulance a few minutes later, 100% O_2 was started. He was taken to the private office of the plant physician approximately five miles away. The plant physician examined the patient in the ambulance and found a severely and acutely ill patient who did not respond, had labor respirations and foaming pinkish material from the mouth and nose. He was immediately transferred to the local hospital and the hospital was notified of his imminent arrival. At the time of admission to the ICU of the local hospital, physical examination revealed an unconscious and cyanotic patient with pinkish material foaming from the mouth and nose. Respirations were rapid and grunting. There were first and second degree burns on the neck, eyes, left antecubital fossa, glans penis, scrotum, and both lower legs. The blood pressure was 160/100, pulse was 120 and respirations were 40. Both lungs were full of fine and harsh rales. Heart

sounds were distant with no murmurs. The abdomen was soft. The urinary bladder was slightly increased with some urine in his trousers. All extremities were spastic. Laboratory data included Hct. of 48%, WBC of 15,000 with 89% polys, sodium was 142 mEq., potassium 3.7 mEq., chloride 107 mEq., and the CO_2 content was 15 mm of mercury, creatinine was 1.7, BUN 18. EKG showed sinus tachycardia at 120.

The young man was placed on rotating tourniquets and a tracheostomy was done without anesthesia. The profused pink pulmonary secretions had to be constantly suctioned. Bennett valve positive pressure O_2 was initiated and a cut down on the right ankle was performed. Fluid was started and he was given 1 gram of Methyl Prednisolone I.V. Over the next hour a total of 25 mgs. of I.V. Valium and calcium gluconate were given because of extreme extremith spasms. An opthalmologist saw the patient and applied NeoDecadron Opthalmic Ointment to the burns of the eyes and face. Because of extreme pulmonary difficulties of the patient and because the hospital did not have the facilities to do the appropriate blood gas studies, it was felt best to transfer him to a facility which had these capabilities. Accordingly, two hours after admission the young man was sent by ambulance on positive pressure 100% O_2 to the Respiratory Care Unit of a University Hospital approximately 75 miles away. He was accompanied by a registered nurse and a fourth year medical student. On arrival at this facility, approximately four and one-half hours to

five hours following the accident, examination revealed a blood pressure of 140/98, pulse 110 and regular, respirations 18 and temperature of 99.4°. He was unresponsive with spontaneous but irregular respirations. The burns of the body were as described above. Examination of the eyes disclosed the pupils to be constricted with marked edema of the conjunctive which were red and appeared to be burned with loss of surface epithelium. The neck was supple with no neck vain distention. The trachea was in the midline. Examination of the heart was essentially negative. The lungs were clear to percussion with generalized expiratory and inspiratory rales and rhonchi. There was also generalized expiratory wheezing. The neurological examination disclosed deep tendon reflexes to be slightly diminished throughout and with no pathological reflexes. Admission laboratory data revealed the hemoglobin at 18 with hematocrit of 52%. There were 36,000 white cells with 90% polys. Subsequent white cell count showed a return to near normal levels. Urinalysis on admission disclosed 1+ proteinuria with 3+ sugar. The urine was positive for blood and the sediment was loaded with red and white cells. Blood chemistries were essentially normal except the serum electrolytes disclosed the potassium at 3.0. There was also an elevation of SGOT to 118 ml., and the LDH to 424 ml. BUN was 19 and creatinia 0.9, blood sugar was 231 with an I.V. running. Creatinine clearance was 140 cc. per minute. An EKG was normal. Chest X-ray disclosed generalized alveolar and interstitial infiltrates. The patient was immediately admitted to the Respiratory Intensive Care Unit and blood gases at the time of

admission disclosed a PO_2 of 28 with a PCO_2 of 27, pH of 7.4 and bicarbonate of 16. These studies were obtained with the patient breathing room air. He was then placed on a Bennett MAI volume respirator and with 60% oxygen, had blood gases that were near normal except for mild alveolar hyperventilation. He was continued on Ampicillin and high dosages of Solu-Medrol. During the first day of his hospitalization he was given 3 units of blood plasma along with other I.V. fluids. Eye and burn consultants were obtained and the patient's eyes were treated with local steriods and antibiotics and he was given atropine ophthalmic drops. The patient gradually improved and by the fourth day of hospitalization was able to take clear liquids and was removed from the respirator for brief periods of time. His temperature remained elevated and during the course of hospitalization he had peaks as high as 103° to 105°.. Because several sputum cultures showed acrobacter, he was given a course of therapy with Kanamycin for seven days and during this therapy he became afebrile and had no further evidence of fever. His burns gradually improved and there was marked eye improvement with no manifestation of scarring or permanent damage. At the time of discharge, arterial blood gases disclosed mild hypoxia on ambient air with PO_2 of 57 PCO_2 . pH was within normal limits. The tracheostomy tube was removed on the fourteenth day.

At the time of a six-month checkup, the patient was working every day, had normal vision and no pulmonary symptoms except for a mild cough.

COMMENT

Although there was ocular damage in this case, no increase in intraocular pressure was reported nor was there residual eye damage. This is probably because treatment of the damaged eyes was started within 45 minutes after the occurrence of the accident.

SOME PITFALLS OF URINE ANALYSIS

N73-17089

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Laboratory Services

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San Antonio, Texas

Urine analysis was introduced by Richard Bright of Guys Hospital in 1827. For the next hundred years a vast amount of literature was published on the examination of urine. During this hundred years the clinician became supremely confident that by study of the urine he could diagnose renal disease accurately and treat it rationally. The work of Thomas Addis brought the microscopic study of the urinary sediment to higher perfection by the introduction of quantitative methods.

Urine analysis is even more refined today than it was thirty or forty years ago; however, there is a disturbing tendency to find a real shortage of laboratory technicians adequately trained in the art of urine analysis and all too often the test of urine is done by the least experienced member of the laboratory staff.

These questions can be asked: Is routine urine analysis too simple? Are rewards too small for the time spent in the laboratory? Are the tests unreliable?

Another question we may ask: If we relegate urine analysis to the lowest position among laboratory tests how else are we to diagnose renal disease? (1)

In the mid-1930's Henry Christian wrote: "It is impossible to diagnose accurately during life the anatomical kidneys that will be found after death." This was the turning point of urine analysis and examination of urine became in some respects passe. As a result, the examination of urine is often relegated to a minor place in the medical

curriculum. Although most hospitals and clinics insist on a urine analysis recorded on the patient's chart, they rarely ask for it to be repeated or for it to be repetitively examined during a patient's course of illness. The same clinicians would be horrified if you suggested that they should listen to the heart only on the day of admission and need not listen thereafter.

In the last decade the percutaneous renal biopsy has become an extremely accurate tool for diagnosing of renal disease during life. However, the biopsy must be correlated with the urine analysis to arrive at the physiologic and dynamic changes that may be taking place in the kidneys.

There has been a progressive simplification of urine testing by the introduction of tablets, tapes and sticks. These are useful in that they actually require no laboratory, and can be run and read correctly by intelligent patients as well as physicians by the bedside. We are not at the stage where we can do a complete urine analysis with one dip stick. These methods are extremely sensitive, extremely accurate and speedy.

Dip sticks are made of selected cellulose of standard porosity. Their tips are impregnated with chemicals which react with normal substances in the urine to produce colored end-products. In some tests the depth of color produced is related to the concentration of an abnormal substance in the urine. This color can be matched against

color standards. The rates of reaction on the impregnated chemicals are standard for each dip stick and color changes must be matched at the correct time after dipping for each stick. These times of matching are given in the instructions which accompany each type of dip stick.

If dip sticks are kept too long in the urine the chemicals impregnated on the cellulose may be dissolved out and the results may be inaccurate. When more than one reaction is arranged on a single stick, which is the common practice, the chemical reagents for each test are separated from one another by a barrier impermeable to water made by impregnating the cellulose with plastic.

Tablets in general are designed from the same principle as the dip stick, except as noted below. The reaction starts when the tablets are moistened with urine. Neither the dip sticks or tablets will work after they have been exposed to moisture before they are used. Therefore, they should be kept extremely dry and free of moisture. It is imperative to read and understand the directions that come with each stick and tablet and follow these directions implicitly. Otherwise, pitfalls may be encountered that could be misleading and lead to erroneous assumptions. (1)

In the case of the glucose test tables these utilize in copper sulfate reduction the same as the Benedict test for glucose. The dip sticks use the glucose oxidast test and are specific for glucose only.

No laboratory test can be any better than the specimen on which it is performed. This is particularly true of a urine specimen. A specimen that is over two hours old and improperly preserved will show a

loss of formed elements such as casts, red cells, white cells in the sediment and this could be extremely misleading. This is especially true in urines that are alkaline and have a low specific gravity.

Old specimens also are hazardous in that they may give a false negative protein determination with the sulfosalicylic acid test and a false positive protein test with the stick if a stale ammoniacal specimen is tested.

In testing for protein it is important to examine the supernatant urine after centrifugation. This will help eliminate false positive proteins due to the presence of mucus from vaginal secretions or mucus from the seminal vesicles, pus cells and red cells that may be in the urine.

The testing for glucose is another critical procedure. It must be kept in mind that hyperglycemia may occur without glycoseria. This is most likely to be found with an early onset of diabetes and also in diabetics whose onset occurs in middle age or later life. Not infrequently there will be no sugar in the morning specimen of a diabetic.

The greatest hazard in glucose determination is the presence of reducing substances such as listed in Table I. (2)

TABLE I - REDUCING SUBSTANCES IN URINE

Fructose	Ketone bodies
Lactose	Sulfanilamide
Galactose	oxalic acid
Maltose	Hippuric acid
Arabinose	Homogentisic acid
Xylose	Glucuronic acid
Ribose	Formaldehyde
Uric acid	Isoniazid
Ascorbic acid	Salicylates
Creatinine	Cinchophen
Cysteine	Salicyluric acid
L-dopa	

The principle of the Benedict's test for glucose involves copper sulfate, which on boiling with reducing agents is reduced to a red or yellow precipitate of Cupric oxide in a hot alkaline solution. The commercial tablets work on the same principle and may give a false positive urine glucose with any of the reducing substances.

The recent report of Feldman et al (3) deserves careful attention. They found that a negative glucose oxidase (stick) test may occur in patients with alkaptonuria or carcinoid syndrome. More interesting was the observation that aspirin as well as L-dopa may produce metabolites in the urine that may give a false negative urine glucose determination with the glucose oxidase reaction on sticks.

The responsible agents for these reactions are potent reducing metabolites, such as gentisic acid, homogentisic acid or 5-hydroxyindole acetic acid. They act by keeping the indicator dye O-tolidine in its reduced form. These workers also found that high concentration of ascorbic acid added to a glucose containing urine gave a false negative reaction with both the sticks and test tape. Lesser amounts of ascorbic acid (10 mg./ml.), however, were detected with test tape.

It was found that test tape when used according to the manufacturer's instructions and only a tip was immersed in urine that a line of color develops at the diffusion point. This can be repeated with the lab sticks, but the manufacturer's present instructions are to immerse the sticks. When this is done, a false negative test is obtained. Using the test tape technique allows the lab stick to act like a mini-ascending chromatography system.

The amount of aspirin ingested that led the false negative urine glucose determination ranged upward from 2.4 grams in a 24-hour period (7, 5 grain tablets).

Many of the reducing substances tend to turn the urine dark on standing. Any dark urine should be suspected to reducing substances as well as porphyrins or hemoglobin or other endogenous substances.

In any event, it is prudent to insist that careful attention be given to urine analysis. It is equally important that only fresh specimens be used for examination. If there is to be a delay, refrigeration of the specimen or the use of different preservatives will help. The proper selection of preservatives is detailed and complicated, and one should consult a laboratory text for proper preservative procedures. For routine analysis the tablets that have been used for many years by the life insurance companies are excellent. (4) The composition of these tablets is as follows:

COMPOSITION OF EACH TABLET

Potassium acid phosphate, 100 mg.

Sodium benzoate, 50 mg.

Benzoic acid, 65 mg.

Metheramine (Urotropine), 50 mg.

Sodium bicarbonate, 10 mg.

Mercuric oxide (red), 1 mg.

One tablet will preserve 2 ounces of urine. Already prepared tablets of this type may be obtained commercially. One source is the R. P. Cargille Laboratories, Inc., 55 Commerce Road, Cedar Grove, New Jersey, 07009.

These tablets will preserve the formed elements for microscopic study and not interfere with tests for glucose, acetone, protein, or bile. Sodium potassium and hormone studies are precluded when these preservative tablets are used.

Abnormally colored urines often present a problem in the laboratory. Page and Culver (5) discuss this in a most lucid fashion. Normal varies in color from faint yellow to amber depending on the concentration. The main urinary pigment is urochrome. This is made up of several substances that have not been chemically characterized. There is another reddish pigment of unknown composition called uroerythrin. This pigment co-precipitates with urates in acid urine.

Abnormal appearance of a urine sample may be due to the presence of formed elements which can be removed by centrifugation. If an abnormal color remains in the supernatant, this may be due to certain exogenous substances excreted in the urine or to endogenous abnormal pigments. Table II, adapted from Page and Culver (5), lists the common exogenous pigments that may color the urine.

The Table follows on page 8.

TABLE II - COMMON EXOGENOUS URINARY PIGMENTS

SUBSTANCE	SOURCE	COLOR OF URINE	
		ACID	ALKALINE
Aloes	Food	Red	Yellow
Anthracene derivatives (including chrysophanic acid (rhei, cascara, senna, and frangula)	Cathartics	Yellow-Brown	Red-Violet
Antipyrine	Analgesic	Red (all changes not known)	
Congo red	Test dye	Yellow	Red
Emodin	Anticoagulen	Colorless	Red
Fenol	Poisoning	Colorless	Urinary oxidation of hydroquinone is olive to black pigment
Phenolsulfonphthalein	Cathartic	Colorless	Red
Phenolsulfonphthalein	Test dye	Colorless	Red
Bromsulfalein	Test dye	Colorless	Red
Pyridium	Analgesic	Red	Colorless
Santonin	Anthelmintic	Yellow	Pink
Thymol	Antihelminthic	Colorless	Thymol hydroquinone turns olive on oxidation
Trypaflavin	Drug	Red	Red

Endogenous pigments that may color the urine hemoglobin, myoglobin, bile pigments, certain indoles, porphyrins, and their derivatives, homo-

gentisic acid and melanogen. Methods for identification of these substances are contained in most standard laboratory texts.

Another finding in urine that frequently causes concern in a non-diabetic patient is the presence of ketone bodies. The ketone bodies, acetone, acetoacetic acid and beta hydroxy butyric acid appear in the urine as a result of increased fat catabolism. They may appear in patients on high fat-low carbohydrate diets, in starvation and in diabetics.

The foregoing are just some of the problems that may arise during the course of a urine examination in the laboratory. They represent, in the author's experience, some of the common problems. There are many others. Since a urinalysis should be regarded as "renal biopsy" in many respects the tendency to treat it casually is no more warranted than was the tendency to overestimate its value that was the vogue in the early years of the present century.

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BACTERIAL IDENTIFICATION USING LIGHT-SCATTERING MEASUREMENTS: A PRELIMINARY REPORT

by

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SUMMARY

The light-scattering properties of single bacterial cells were examined as a possible means of identification. Three species were studied with Streptococcus faecalis exhibiting a unique pattern; the light-scattering traces for Staphylococcus aureus and Escherichia coli were quite similar although differences existed. Based on preliminary investigations, the light-scattering approach appeared promising, with additional research needed to include a wide variety of bacterial species, computer capability to handle and analyze data, and expansion of light-scattering theory to include bacterial cells.

INTRODUCTION

It is generally recognized that the modern microbiology laboratory utilizes procedures developed in the 19th century. With a few exceptions, bacteria today are cultured, purified, counted and identified in much the same manner as they were 100 years ago. Unlike the rapid progress made in automating clinical biochemistry, only faint progress has been made in the development of automated techniques for the routine procedures in a microbiology laboratory[4]. On the other hand progress has been even slower in developing new methods for the identification of bacteria although a number of approaches are being pursued including the use of gas chromatographs[2]. This paper describes a different approach to the problem of identification and is based on the light-scattering properties of single bacterial cells[5]. It is the purpose of this report to describe the light-scattering technique, present some preliminary data for a limited number of bacterial species, indicate problem areas and the need for further investigations.

MATERIALS AND METHODS

Bacteria:

Staphylococcus aureus 12600, Streptococcus faecalis 12755, and Escherichia coli 12014, obtained from the American Type Culture Collection (Rockville, Maryland) were used in these studies. Stock cultures were maintained on Trypticase Soy Agar (TSA;BBL) slants at 5C and transferred monthly.

Cell Suspensions:

To prepare cell suspensions for light-scattering measurements, the organisms were subcultured into Trypticase Soy Broth (TSB;BBL) and incubated at 35C for 24 hours. The broth cultures were then diluted 10-fold in sterile distilled water and 0.5 ml of each dilution used to inoculate TSA plates which were incubated at 35 C for 18-20 hours. Surface growth was scraped from either the 10^{-1} or 10^{-2} dilution with an inoculating loop and suspended in nine ml of distilled water; care was exercised to avoid contaminating the suspension with agar. Turbidity of the bacterial suspension was adjusted to compare with a suspension of 0.81 micron polystyrene latex spheres (Dow Chemical Company) prepared in the following manner; 0.02 ml of a stock suspension of latex spheres, containing 10 percent solids, was added to nine ml of distilled water and further diluted 1 to 10 in water; experience has shown that the bacterial suspensions contained about 10^7 cells per ml. All suspensions were thoroughly vortexed to insure uniform dispersal and to breakup clumps of spheres or bacteria.

Light-Scattering Measurements:

The bacterial suspension was introduced into the scattering cell of the Differential II light-scattering instrument (Science Spectrum, Inc.) by means of a DeVilbiss glass

nebulizer (the DeVilbiss Company) which had been cleaned by soaking 24 hours in 0-SYL (National Laboratories), rinsed twice in distilled water and air dried; prior to actual use the nebulizer was rinsed twice with distilled water filtered through a 0.2 micron filter. The nebulizer was then positioned in the Differential II module and the input line from the nitrogen tank was connected to the nebulizer and the output line from the nebulizer attached to the scattering cell. One ml of the bacterial suspension was added to the nebulizer and the bacteria introduced into the scattering cell by depressing the nebulizer control button. Through a combination of pneumatic and electrostatic controls, an individual cell was isolated and positioned in the center of the laser beam. The cell was then locked into position by means of an automatic levitator. The laser light scattered by the bacterial cell was intercepted by a detector which moved in a horizontal arc of nearly 180° around the bacterium. The amplified signal from the detector was then fed to a recorder which automatically recorded a plot of the scattered light intensity as a function of angle. All measurements were made with the photomultiplier detector input set at 1000 volts.

DISCUSSION OF RESULTS

At the outset it should be pointed out that these results are preliminary and considerably more effort will be required before firm conclusions can be reached regarding the value of this technique for identifying bacteria. Even though the data are limited, some interesting observations have been made on the three species studied. The light-scattering traces for Streptococcus faecalis, Staphylococcus aureus, and Escherichia coli are presented in Figure 1. Four scattering traces for each bacterium are shown. Some obvious differences and similarities are apparent,

i.e., the absence of a fourth peak in S. faecalis and the overall similarity between the traces for S. aureus and E. coli. In an attempt to delineate these differences and similarities, the scattered light intensity for each peak angle was measured and these data are presented in Table I. For ease of reference the peaks were labelled alphabetically, i.e., the first peak A, second B, etc., with an arbitrary scale of 0 to 100 set for the relative intensity of the scattered light. After reviewing the figures and the data in Table I, only general comments can be offered at this time.

The most apparent difference between the three species was the absence of a fourth peak for S. faecalis and the positions of the peak angles for this organism which generally were shifted to the right about 10 to 20 degrees as compared to the other two species.

Major differences between the other two species was the increased height of peak A for E. coli over S. aureus and the reverse situation for peak B; peaks C and D appeared at the same angle with about the same scattered light intensity.

The results of these initial investigations are encouraging. However, there remains the need for more exhaustive studies in the following areas; scattered light measurements are needed for a wide variety of bacteria which are taxonomically and morphologically similar. In this regard, the similarity between the traces for a coccus, S. aureus, and a rod, E. coli are difficult to explain although the possibility exists that in the population of E. coli examined, some cells were coccoid in shape and it could have been these cells which were measured. In view of the fact that identification with the light-scattering technique is based on a limited number of parameters, i.e., size, shape and refractive index of the cell and cytoplasm[1],

there exists the need for computer capability to store, retrieve and analyze large amounts of data for statistical analysis, such as distributions, correlations, etc. Along these same lines the need also exists for an extension of current light-scattering theory and the development of new theory for complex bacterial cells[5].

Finally, an operational problem which has to be corrected electronically or dealt with through statistical analysis is the distortion of the traces resulting from movement of the bacterial cell while it is trapped in the levitator. Unlike latex spheres which consistently produce "clean" traces, the majority of bacterial cells move in either a vertical or horizontal plane and the resultant light-scattering traces are difficult to analyze.

As pointed out earlier in this report, considerably more work will be required before the value of this technique in identifying bacteria can be determined. Based on limited experience, it would appear that the light-scattering method has promise but its relative position in the taxonomic scheme of identifying bacteria will depend on the results of future studies.

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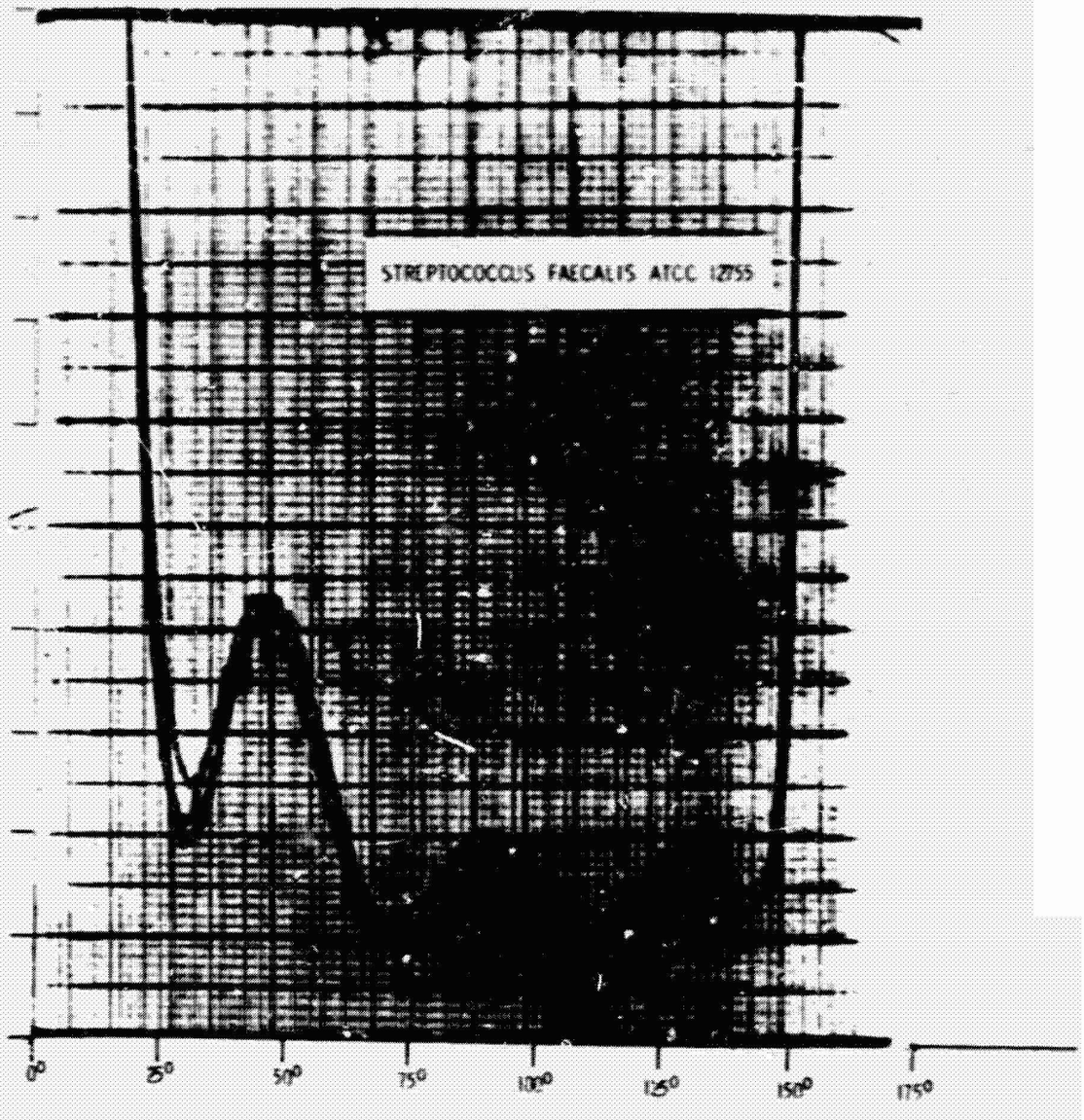

FIGURE 1

Differential scattered intensity of 514.5 nm vertically polarized light from single cells of Streptococcus faecalis, Staphylococcus aureus, and Escherichia coli. Four traces are shown for each species.

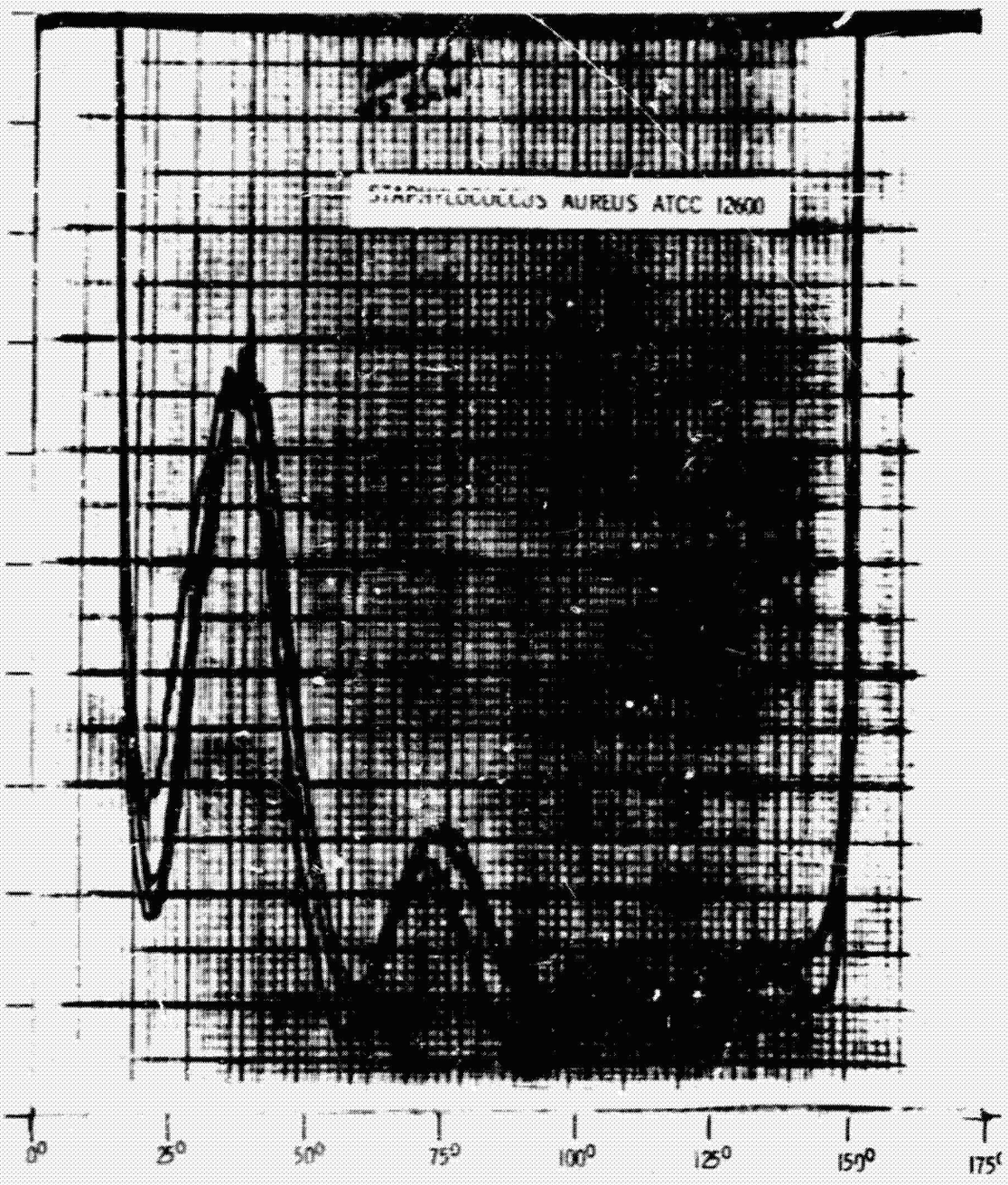

FIGURE 1 (continued)

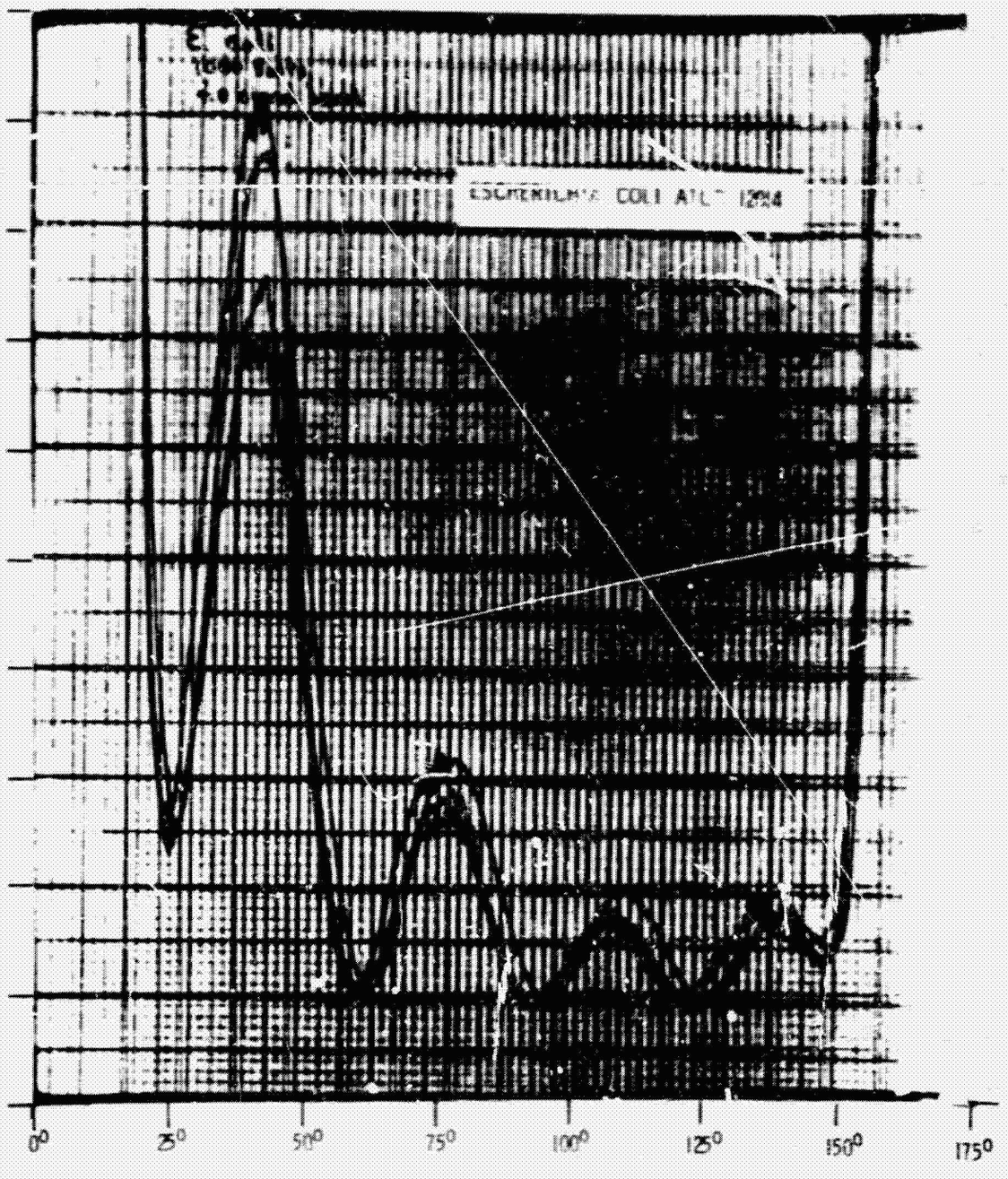

FIGURE 1 (continued)

TABLE I

SCATTERED LIGHT INTENSITY AS A FUNCTION OF PEAK ANGLE
FOR THREE SPECIES OF BACTERIA

Bacteria	Peaks							
	A		B		C		D	
	SLI*	PA*	SLI	PA	SLI	PA	SLI	PA
Streptococcus faecalis	42** (40-43)	48°	18.1 (17-20)	95°	17.7 (17-19)	13.		
Staphylococcus aureus	68.2 (65-72)	40°	24.5 (23-25)	77°	17.7 (17-19)	110°	15 (14-16)	135°
Escherichia coli	81.2 (72-92)	35°	18.1 (17-20)	80°	24.5 (23-25)	110°	15 (14-16)	135°

*SLI - Scattered Light Intensity, Scale of 0 to 100

PA - Peak Angle

**Average ( ) Spread

N73-1709

THE NASA-USPHS-HEALTH EVALUATION AND [illegible]

by

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ABSTRACT

An exercise program was initiated in a Federal agency in order to assess the feasibility of such a program, as well as to identify the factors which influenced volunteering, adherence, and effectiveness of the program. The program was utilized by 237 of the 998 eligible Federal employees, with a mean attendance of 1.3 days per week. Those who volunteered perceived a need for increased physical activity, felt they had sufficient time to participate, and derived subjective as well as objective benefits. Significant improvements were found in heart rate response to the standard exercise test, body weight, skinfold measurements, and triglycerides. A consistent relationship was found between subjectively reported effects of the program on work, health habits, and behavior, and improvement in cardiovascular function, based on treadmill performance. Numerous personal and programmatic factors influencing volunteering and participation were identified.

Physical activity may exert a positive influence on the preservation and enhancement of cardiac status.[1] A number of experimental and epidemiological studies have defined an association between physical inactivity and greater frequencies of sudden death, myocardial infraction, and coronary artery disease in general.[2-6] This associational evidence is strong enough to cause many physicians and other health professionals to encourage increased physical activity as a preventive[7] and as a health enhancement[8] measure, and to seek ways of institution of effective exercise programs for sedentary populations.

This paper deals with the results of an "on-the-job" Health Evaluation and Enhancement Program conducted jointly by the Preventive Programs Section of the Heart Disease and Stroke Control Program of the U.S. Public Health Service and the Division of Occupational Medicine at NASA Headquarters.

Slide 1

The objectives of this Program were:

1. To assess the feasibility of establishing an effective exercise program, with careful medical evaluation, within the employment setting of a Federal agency.
2. To identify and define those factors that influence volunteering, adherence, and program effectiveness in modifying selected cardiovascular risk factors as well as health attitudes and behavior.

3. To provide guidelines for the future development and administration of effective exercise programs within government and industry.

Slide 2

All eligibles (male, age 35-55, Government pay rating of 11 or higher, directly employed by NASA in the Washington, D.C. area) were identified from a payroll listing. These men were notified of the institution of the Program by an announcement in the NASA Weekly Bulletin, by individual letters, and by group meetings. Volunteers were asked to provide evidence of consent from their personal physician. Each volunteer then received a baseline evaluation consisting of a self-administered medical and dietary history, chest X-ray, CBC with differential, urinalysis, 2-hour post-prandial blood glucose, fasting cholesterol, fasting triglycerides, uric acid, creatinine, anthropometric measurements, and a detailed physical examination. Social-psychological data dealing with the individual's health attitudes, habits, and practices were obtained through personal interview and self-administered questionnaires. In addition, resting ECG, Double Master, and multistage treadmill tests were conducted at the Applied Physiology Laboratory of the Heart Disease and Stroke Control Program at Georgetown University.

Each volunteer was then briefed as to the results of his baseline evaluation, instructed in how to take his own carotid pulse, and asked to join the exercise program of his choice.

The Stress Lab Program, located in the sub-basement of one of the NASA buildings, was a supervised program consisting of a circuit of

sequential activities: warm up, treadmill, speed bag, bicycle, wall pulley, rope jump, sit ups, rowing, balance beam, treadmill, medicine ball, and taper off. Exercise loads were individually tailored to that each subject reached 85% of his maximum predicted heart rate[9] on the bicycle, rope jump, rowing, and second treadmill exercises, and 70% of his maximum predicted heart rate on the remainder of the exercises.

The Jogging Program was also a supervised program conducted at the Anacostia Naval Annex, about 10-15 minutes drive from NASA. The Program consisted of intervals of jogging and walking, progressing in both actual time spent jogging and in rate of speed. The same heart rate prescription methods were used.

The Individual Program was unsupervised, and used about the same exercise program as was used for the joggers. However, the subjects did have the option of running in place, bench stepping, bicycling, swimming, basketball, and skiing. Subjects in all programs were asked to exercise for about 25 minutes three or more times per week.

After the program had been in operation for about six months, each participant was interviewed concerning factors influencing his adherence. At 12 months, the following parameters were re-assessed: selected health habits and attitudes, cholesterol, triglycerides, resting ECG and treadmill test, dietary patterns, anthropometric measures, physical activity and smoking patterns, and program effects on work, health, habits and behavior.

Slide 3

A total of 998 persons met the eligibility criteria. Of these, 340 volunteered for the program, and 271 completed the baseline examination. Approximately 60% joined the Stress Lab Program, 20% joined the Jogging Program, and 20% joined the Individual Program. Of those who actually joined an exercise program, 237 or about 92% also participated in the retest examination. Random samples of non-participants were interviewed concerning their reasons for not joining the Program. Of the reasons cited, job or work-related reasons such as heavy workload, travel schedule, and lack of time were most prevelant. Next were reasons relating to operational aspects of the Program such as the lengthy examinations and the need for consent from a private physician. The third reason mentioned was that the non-participant felt he was already in good physical condition, and did not need to be more physically active.

Slide 4

Adherence, as assessed by attendance, is remarkably similar for the three programs. The mean attendance was a little less than half of that prescribed. During an average week, about half of the subjects did not exercise at all, about one quarter exercised one or two days, and one quarter exercised three or more days. About six months after the program began, the participants were interviewed concerning the factors which were influencing their participation. Of the factors cited as having a negative influence on their participation, workload,

travel, conflicts between job and Program schedule, and physical problems were mentioned most frequently. Lack of motivation was mentioned by only 4% of the participants.

Slide 5

Repeat treadmill tests were conducted on 237 of the participants one year after their baseline examination. In addition, 18 men, depicted as "non-exercisers" were retested. These men were physically inactive before, during, and after the Program was initiated, and were included to demonstrate any change in heart rate response that might occur over the year interval which was not due to the exercise program. Indeed, there was a difference, but not a statistically significant one. The heart rate responses of the middle and highest tercile groups of attendance were significantly different from the lowest tercile of attenders at the $p=0.01$ level. There was no significant difference between the middle and highest tercile groups.

Slide 6

There was a distinct increase in the mean change in time on the treadmill required to reach a heart rate of 140 beats per minute in the middle and highest terciles of attendance in the Stress Lab Program, and in the highest attendance tercile in the Jogging Program. These differences are significantly different from the total lowest tercile group at the $p=0.01$ level. No significant difference was obtained for the tercile group in the Individual Program.

Slide 7

Simple linear regression analyses were run between attendance and selected re-test parameters. Correlations were demonstrated between attendance and heart rate response (0.34 and 0.36), triceps skinfold (0.33), and body weight (0.30). There was no evidence of association between attendance and cholesterol. The correlation with triglyceride levels was weak, but significant.

Slide 8

The same analyses were run for each exercise program. Correlations between attendance and exercise heart rates, and skinfolds were greatest among the men in the Stress Lab Program, and smallest in the Individual Program. Significant associations between attendance and triglycerides, systolic blood pressure, and diastolic blood pressure were found only in the Stress Lab Group. A separate multiple regression analysis was performed involving attendance versus heart rate measures and body weight. The results of this analysis indicate that the changes in heart rate were not significantly influenced by changes in body weight.

Concurrent with the final medical evaluation, an assessment was made of program effects on the participants' health attitudes and behavior. A self-administered questionnaire was used to determine whether or not participants reported and effects or changes in work, health, habits, and behavior which the participant felt were due to the program. Two-hundred thirty-two participants completed this questionnaire.

Slide 9

The relationship between the reported effects on work performance and attitudes toward work is strong, and correlates well with attendance tercile. The participants reported that they could work harder both mentally and physically, and that they enjoyed their work more, and found their normal work routine less boring.

Slide 10

Changes or effects reported in relation to a person's health included increased positive feelings about one's health status, increase in stamina and energy, weight reduction, and a decrease in the level of stress and tension experienced.

Slide 11

The effects reported on health habits and behavior included change in diet, increased physical activity beyond the program, expanded recreational activities, more adequate sleep and rest, and changes in smoking behavior.

Slide 12

In order to obtain some insight into the accuracy of these effects reported by the participants, multiple comparisons were made between the reported effects and the effects actually measured. One aspect of this analysis concerns comparison of reported effects with change in treadmill test parameters. Those who reported greater stamina, for example, did have greater stamina. In other analyses not presented on this slide, those who reported weight loss actually did lose weight.

Those who reported increased physical activity beyond the program did show slightly greater improvement in their exercise test results than those in the same percile groups who did not report increased outside activity. Therefore, there seems to be some validity to these reported program effects.

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OBJECTIVES OF STUDY

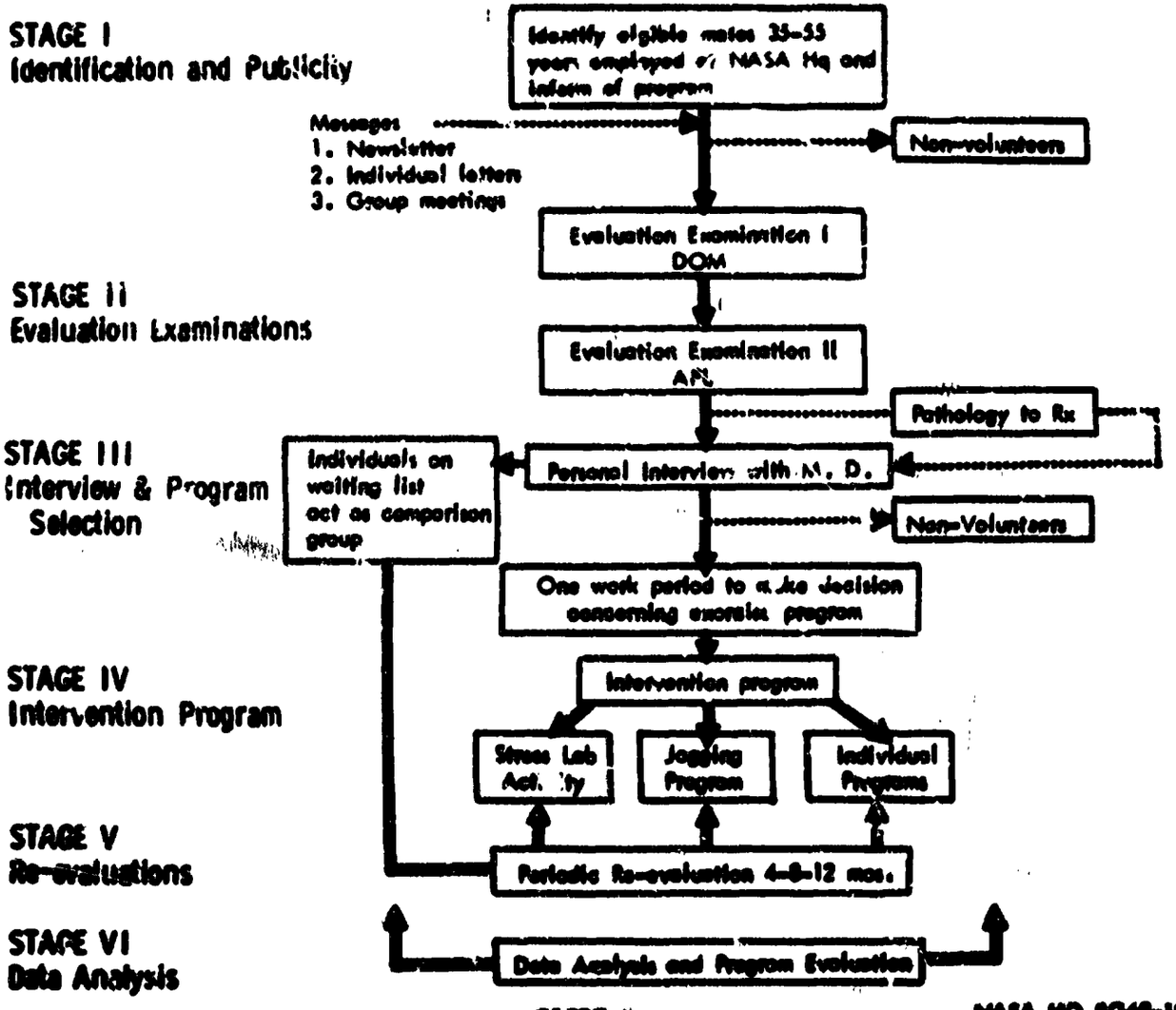
1) TO ASSESS THE FEASIBILITY OF ESTABLISHING AN EFFECTIVE EXERCISE PROGRAM, WITH CAREFUL MEDICAL EVALUATION, WITHIN THE EMPLOYMENT SETTING OF A FEDERAL AGENCY.

2) TO IDENTIFY AND DEFINE THOSE FACTORS THAT INFLUENCE VOLUNTEERING, ADHERENCE, AND PROGRAM EFFECTIVENESS IN MODIFYING SELECTED CARDIOVASCULAR RISK FACTORS AS WELL AS HEALTH ATTITUDES AND BEHAVIOR.

3) TO PROVIDE GUIDELINES FOR THE FUTURE DEVELOPMENT AND ADMINISTRATION OF EFFECTIVE EXERCISE PROGRAMS WITHIN GOVERNMENT AND INDUSTRY.

SLIDE 1

NASA-USPHS HEALTH EVALUATION AND ENHANCEMENT PROGRAM



SLIDE 2

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FREQUENCY DISTRIBUTION OF NASA PERSONNEL BY NUMBER, PERCENT OF ELIGIBLES, AND PERCENT OF VOLUNTEERS

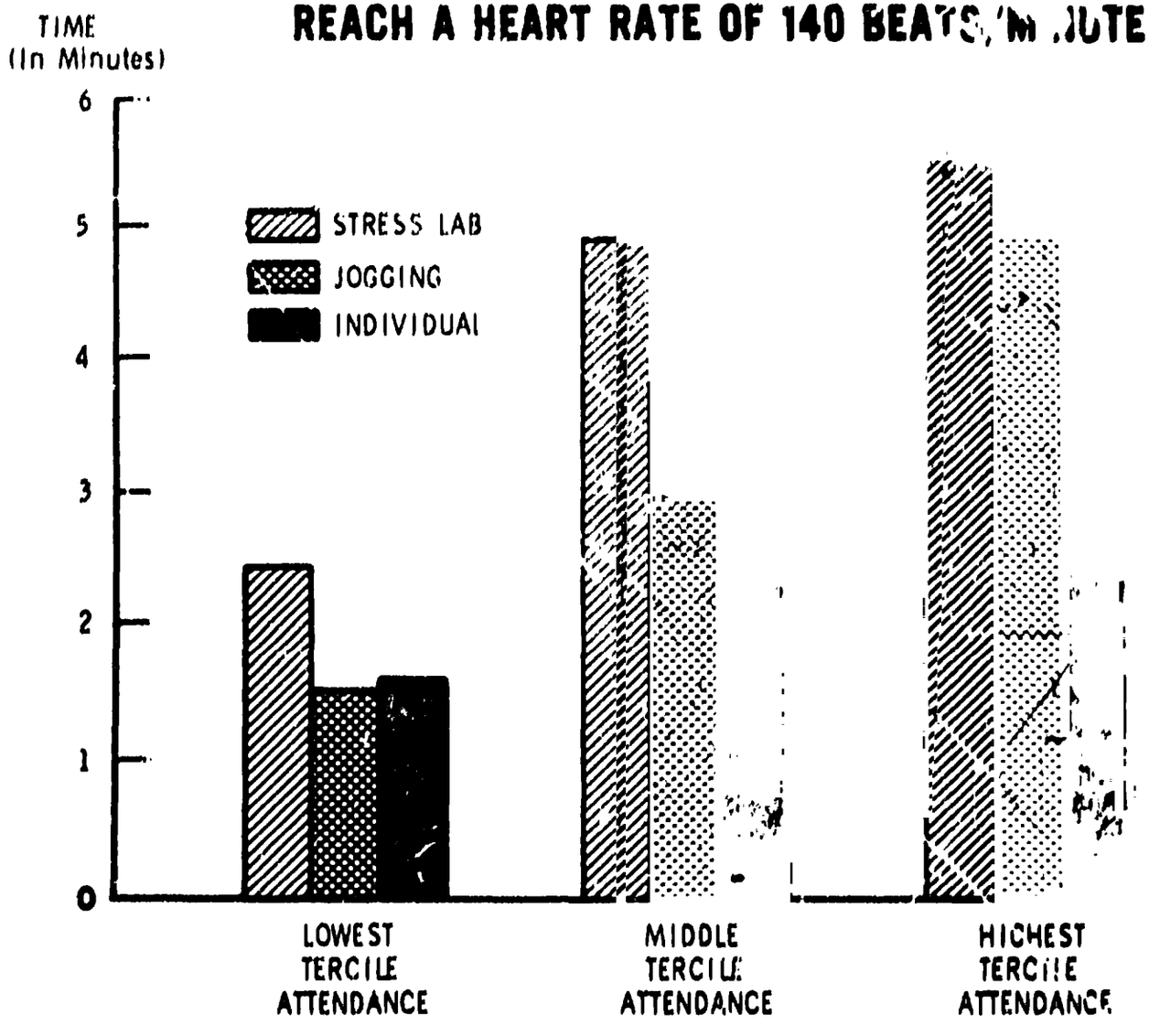
STUDY PHASE	NUMBER OF PERSONNEL	PERCENT OF ELIGIBLES	PERCENT OF VOLUNTEERS
ELIGIBLES	998	100.0	
ATTENDED ORIENTATION SESSIONS •	562 •	56.3	
VOLUNTEERS	348	34.9	100.0
COMPLETED BASELINE EXAMINATION	271	27.3	77.8
ASSIGNED TO EXERCISE PROGRAM	259	26.0	74.4
1) STRESS LAB	156		44.8
2) JOGGING	59		16.8
3) INDIVIDUAL	44		12.6
COMPLETED RETEST EXAMINATION	237	23.7	68.0

• Estimated

SLIDE 3

Treadmill Test Results:

MEAN CHANGE IN TIME REQUIRED TO REACH A HEART RATE OF 140 BEATS/MINUTE



SLIDE 6

CORRELATION OF MEAN DAYS EXERCISED PER WEEK AND SELECTED DEPENDENT VARIABLES (All Participants)

DEPENDENT VARIABLE (Percent Change In:)	COEFFICIENT OF CORRELATION	p VALUE
CHOLESTEROL	-0.01	N. S.
TRIGLYCERIDES	-0.14	0.05
TRICEPS SKINFOLD	-0.33	0.001
BODY WEIGHT	-0.30	0.001
SYSTOLIC BLOOD PRESSURE	-0.18	0.01
DIASTOLIC BLOOD PRESSURE	-0.10	N. S.
12-MIN. STRESS TEST HEART RATE	-0.36	0.002
15-MIN. STRESS TEST HEART RATE	-0.34	0.002

N. S. = Not Significant

SLIDE 7

CORRELATION OF MEAN DAYS EXERCISED PER WEEK AND SELECTED DEPENDENT VARIABLES (By Exercise Program)

DIFFERENT VARIABLE	STRESS LAB		JOGGING		INDIVIDUAL	
(Percent Change In:)	$\bar{R}$	p	$\bar{R}$	p	$\bar{R}$	p
CHOLESTEROL	-0.12	N. S.	0.00	N. S.	0.00	N. S.
TRIGLYCERIDES	-0.27	0.01	0.00	N. S.	0.00	N. S.
TRICEPS SKINFOLD	-0.46	0.001	0.00	N. S.	0.18	N. S.
BODY WEIGHT	-0.37	0.001	-0.25	0.05	-0.07	N. S.
SYSTOLIC BLOOD PRESSURE	-0.34	0.001	-0.21	N. S.	0.00	N. S.
DIASTOLIC BLOOD PRESSURE	0.17	0.05	0.00	N. S.	0.00	N. S.
12-MIN. STRESS TEST HEART RATE	-0.43	0.001	-0.48	0.01	0.00	N. S.
15-MIN. STRESS TEST HEART RATE	-0.47	0.001	-0.40	0.01	0.00	N. S.
NUMBER OF PERSONNEL	149		46		42	

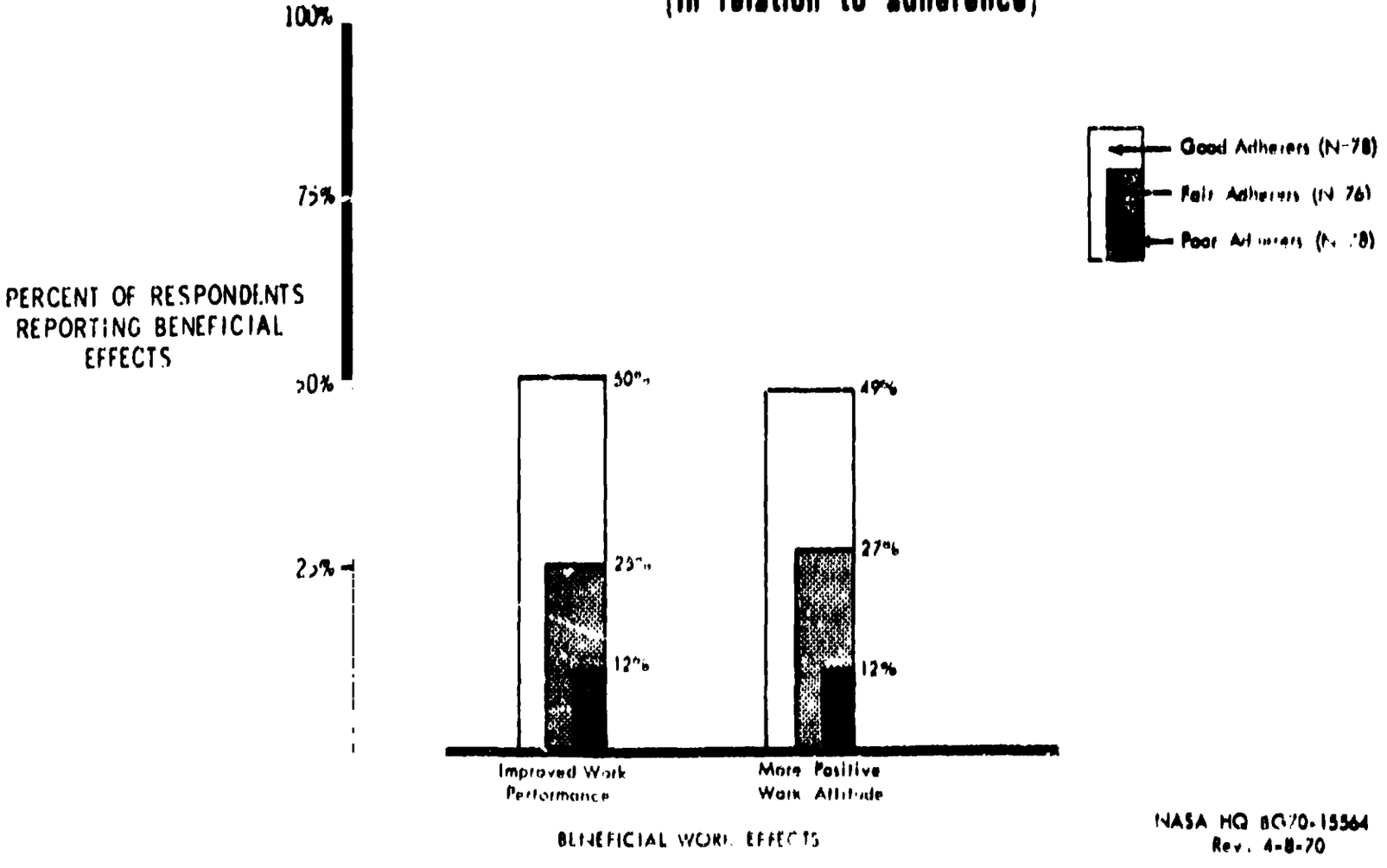
$\bar{R}$ = Coefficient of Correlation
N. S. = Not Significant

SLIDE 8

NASA HEALTH EVALUATION AND ENHANCEMENT PROGRAM

PROGRAM EFFECTS ON WORK

(In relation to adherence)



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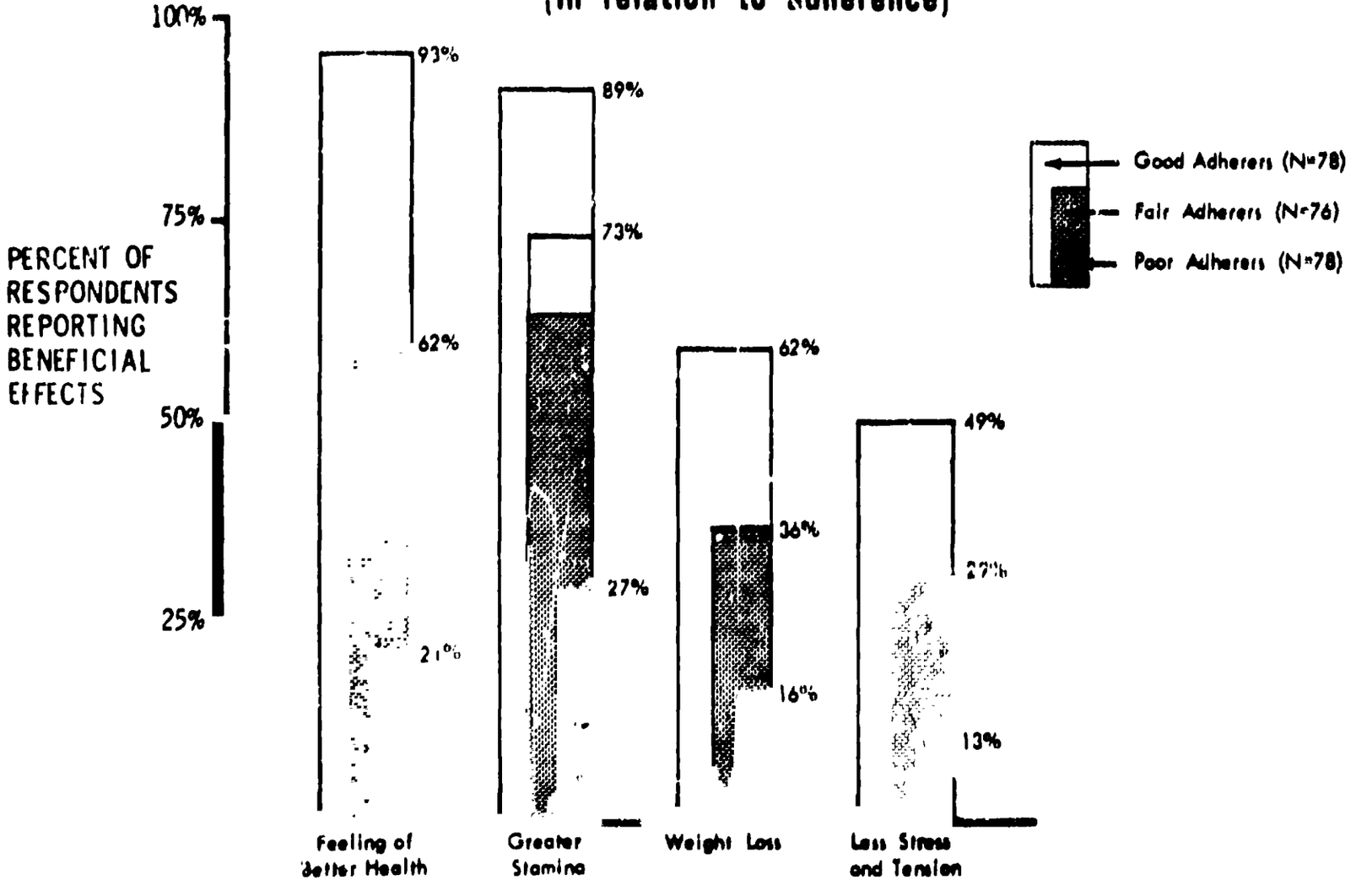
SLIDE 9

NASA HEALTH EVALUATION AND ENHANCEMENT PROGRAM

PROGRAM EFFECTS ON HEALTH

(In relation to adherence)



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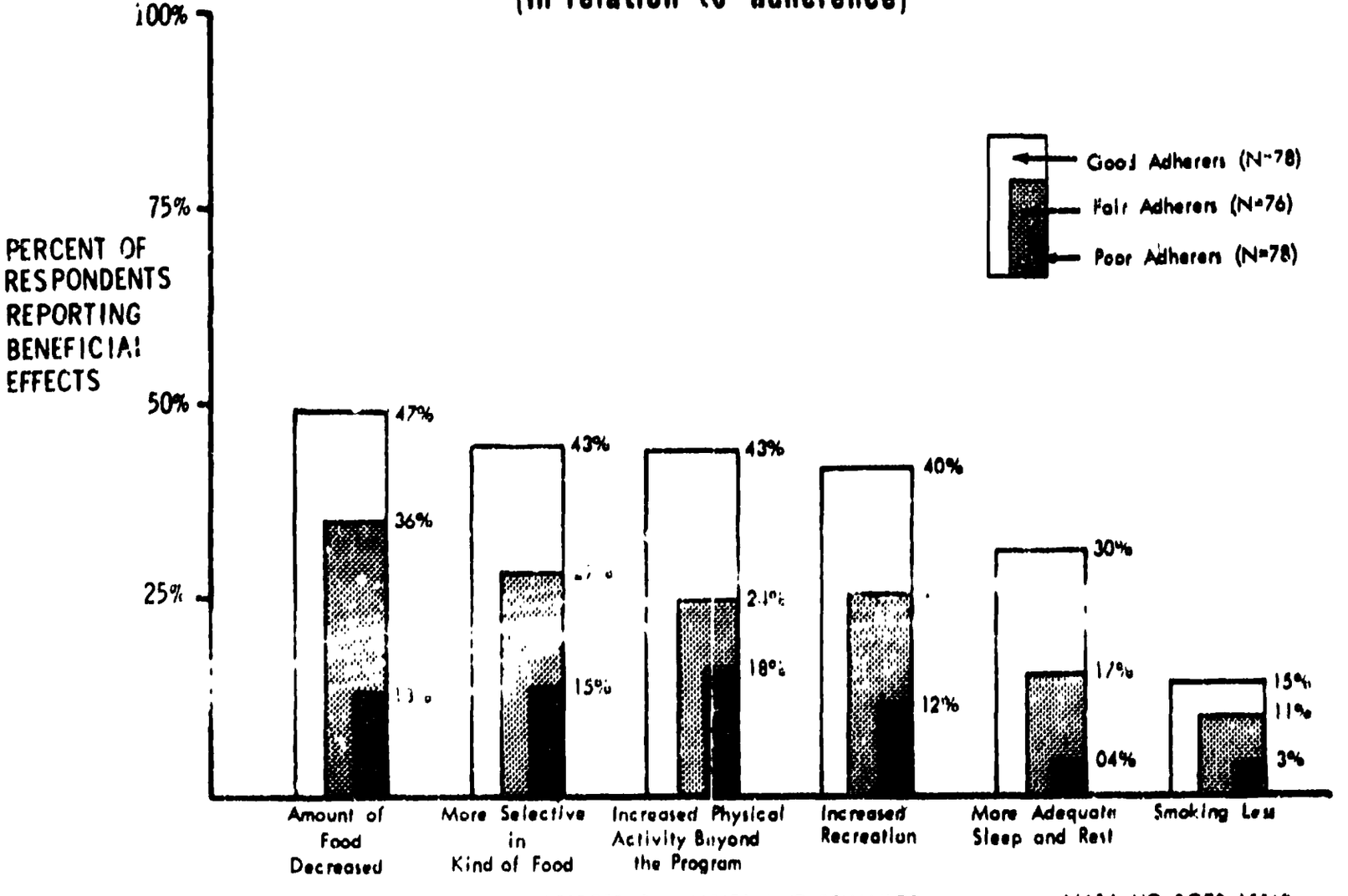
SLIDE 10

NASA HEALTH EVALUATION AND ENHANCEMENT PROGRAM

PROGRAM EFFECTS ON HABITS AND BEHAVIOR

(In relation to adherence)



BENEFICIAL EFFECTS ON HABITS AND BEHAVIOR

SLIDE 11

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NASA HEALTH EVALUATION AND ENHANCEMENT PROGRAM

DIFFERENCES IN MEAN CHANGES OBSERVED IN STRESS TEST PARAMETERS BETWEEN GROUP REPORTING A SPECIFIC PROGRAM EFFECT AND GROUP REPORTING NO EFFECT

DIFFERENCES IN MEAN CHANGE IN STRESS TEST PARAMETERS						
SPECIFIC PROGRAM EFFECTS REPORTED	DURATION OF STRESS TEST (Min.)	TIME TO REACH HR OF 140 bpm (Min.)	TIME TO REACH HR OF 150 bpm (Min.)	HEART RATE AT 12 MIN. (bpm)	HEART RATE AT 15 MIN. (bpm)	MAXIMUM HEART RATE (bpm)
Feelings of better health	1.4**	1.36**	1.15**	6.8**	6.1**	6.5**
Greater stamina	.9**	1.31**	.90**	5.9**	6.3**	6.9**
Greater health interest & awareness	1.2**	2.01**	2.12**	8.6**	8.6**	10.1**
Less stress and tension	1.1**	1.67**	1.16**	7.3**	6.6**	7.6**
Weight reduction	1.0**	1.44*	1.38**	7.2**	8.5**	7.8**
More positive work attitude	.8*	1.73**	1.44**	6.8**	6.2**	6.2**
Improved work performance	.3	.60	.81*	2.4	4.3*	3.3
Amount of food decreased	.7*	1.02**	.63	2.4	3.0	3.5*
More selective in kind of food	.8*	.47	.23	.3	2.1	2.5
More adequate sleep & rest	.6	.92*	1.01*	3.5	2.4	3.1
Increased physical activity beyond the Program	9**	.57	.90*	.2	.1	2.3
Increased recreation	.9*	.57	.63	.6	.9	3.3
Smoking less	.7	.17	.55	.7	.0	2.5

* Indicates a significant difference at the .05 level of confidence between Group reporting an effect & Group reporting no effect due to Program.

** Indicates a significant difference at the .01 level of confidence between Group reporting an effect & Group reporting no effect due to Program.

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N73-17092

IMPACT OF NASA STRESS LAB PROGRAM ON U.S. COLLEGES

by
S. P. deLisser
President

NATIONAL HEALTH SERVICES, INC.

IMPACT OF NASA STRESS LAB PROGRAM ON U.S. COLLEGES

We are all familiar with many of the side benefits accruing to the nation as a result of the NASA missions in space. However, the citizenry, including the congress, often seems to take for granted accomplishments that seemed fantastic in the pre-NASA age - telemetry, miniaturization, high performance metals, etc. - all the way up to lunar geology. Purely as a result of NASA activities the American life style has been profoundly influenced in thousands of aspects. I firmly believe that the space shuttle - Sky Lab - indeed, any NASA program has an ancillary throwoff that justifies its cost regardless of the success of the primary mission. And I have firmly registered this conviction with my Congressman and Senators - as have many others in our organization.

And yet, the pressure mounts for cutting back on NASA programs - I just don't understand it. We don't seem to get our priorities straight!

My purpose today is to describe another small, unheralded - but potentially important effect that the NASA program is causing in the field of physical education in our nation's schools and colleges. Please understand that this is not in any sense a scientific paper nor a research report - it is only a programmatic narrative. My personal "raison d'etre" in the health care field, and in the paramedical service corporation which I head, is in planning and administration. I am a "doer," an implementer of the concepts created by physicians and other scientists. Thus, I won't be upset if you consider me just a change of pace from the exotic concept of Infrasound or the heady wine of Infrared Space Photography which Dr. Park presented yesterday.

The Crisis in Physical Education

Perhaps you did not know that there was a crisis in physical education (to go along with all our other current crises) and, frankly, we didn't either. However, we were approached about a year ago by Professor William Johnson of the Department of Physical Education of the Brookdale Community College, Monmouth County, New Jersey, and he told us about it. Professor Johnson presented a fascinating story of how the conventional concepts of physical education in secondary schools had fallen into disrepute. Students were unhappy, faculty members discontented and steely-eyed administrators were menacing. He set us off on a literature search and a mounting interest and confirmed the existence of a real crises. Consider the following quotation from an article in the Journal of Health, Physical Education and Recreation:

> "Physical education in the secondary school, as we know it, must soon be changed. If we, the teachers of physical education, do not institute the necessary changes, another group or combination of groups will force changes and physical educators will have no choice but to accept them. Throughout the country, college students and, more recently, high school students are demanding a strong voice in the total educational process. They want a say in the subject matter, how it will be

taught, and who will teach it. Many colleges have been asked to do away with required physical education. The students find it repetitious, too time consuming, unrelated to their mode of life, and without purpose in the structure of the institution or the society as they view them."

We also found evidence that this type of criticism was not confined to forums of professional interface - that in fact the Public Press had even picked up some of the criticism and reported instances of actual rebellious action. An article in the Newark Evening News was directly to the point. I quote:

"College students rarely are enthusiastic about physical education classes and when the program was eliminated at the close of the 1968-69 academic year, a collective sigh of relief was heard across the Rutgers College campus here. The traditional two-year physical education requirement, dubbed "fizzed" among other less palatable names, was intended to meet the needs of some 3,000 freshmen and sophomores. It held on despite questions of its effectiveness and value. Educators at all levels have wondered if the time spent on physical education during prime instructional hours was worth it. Many see the reform road as a long one filled with large budget gaps and keen curricular competition between a myriad of subjects. But in addition, the reformers must also convince the great mass of machine-age Americans, who have never exactly flocked to tedious exercises, that there is some intrinsic value in regular exertion."

Of course this situation really should not surprise us. Many of us can remember the vast outcry that stemmed from the World War II statistics on the number of draftees that were rated as physically unfit for military service. The sad state of fitness of the nation's youth has been moaned about ever since and limited steps, such as the creation of the President's Council on Physical Fitness, taken to try to alleviate the situation. The medical profession has been more or less standing aside, although in recent years the effect of fitness on the cardiovascular system has been of great interest. The AMA's Family Health Magazine put together a panel a year or so ago and their report tied the problem directly to the teaching of physical education. In part the article read:

"In America today, 'physical education" comes close to being a farce. Most school gym programs are geared to benefit 10 percent of the children who need it least - the hotshot athletes who hog the gyms, playing fields, and coaches' time. The other more than 41 million children - including the underweight, overweight, shy, scrawny, awkward, handicapped, poorly coordinated, and just plain normal - get short shrift from most of their gym teachers."

and this theme has been echoed and the point of blame focused rather sharply by Dr. Vernal Seefeldt of the University of Wisconsin, who stated flatly:

> "The colleges and university have been doing a horrible job in preparing physical education teachers."

The Physical Education Department at Brookdale Community College had decided not to simply throw up their hands and admit defeat. They were convinced of the values of physical fitness and that there should be innovative methods of teaching physical education which could counterbalance the criticisms. Perhaps the theme for this belief was best phrased by Professor Michael Schoche' who said:

> "We know the worth of physical education, but if we do not meet the needs of the current students in today's world, I fear for our future in the total school curriculum. We must make a break-away from worn out traditions. We must find new spirit, arouse our imaginations, and be certain we are doing a good solid job of teaching necessary skills and not simply organizing a high priced repetitive recreation program."

Now what has all this got to do with NASA? Well, at Brookdale they had taken note of the 1970 article in Fortune Magazine which had referred to the NASA Stress Lab program and stated some of Dr. Fleck's concepts and procedures. This article piqued their interest and a call to Dr. Fleck brought them a referral to the home offices of National Health Services, Inc. and our Vice President for Program Development, Gus Frank. Although our field of work in occupational health, preventive medicine and health care systems has never involved pedagogical education, we volunteered to try to be of assistance to Brookdale in a consulting capacity. As I am sure most of you are aware, NHS has been deeply involved in the Stress Lab program from its very inception, primarily through Dr. Fleck's assignment at the NASA Headquarters Medical Program, (incidentally, Dr. Fleck was elected a full Vice President of NHS, Inc. in 1970) and later on through assignment of the total contract responsibility for the operation of the Stress Lab at NASA Headquarters. A Brookdale delegation visited the Stress Lab, which was arranged through Colonel Limoncelli and Dr. Arnoldi, and they came away a pretty excited bunch of college professors.

The Brookdale Philosophy and Program

After an extended period of discussion and planning an adaptation of the NASA Stress Lab program began to emerge as a possible solution. The basic concept would involve construction of a series of small stress labs to be called "Fitness Learning Centers." The entire philosophy of teaching physical education would be altered and an individualized emphasis on fitness would be the core idea. In an internal memorandum the following recommendations were proposed to the College's Board of Trustees:

"It is recommended that Brookdale extend its philosophy of a learner - and learning-centered institution treating the particular needs of individual students to encompass the broad field of physical education, athletics, and recreation. Rather than an initial emphasis on competitive, spectator sports and the facilities to house them, the individual student must be considered first before the needs of the group. ....but the constant image of "physical education" in its orientation to competition, teams, field house, transportation schedules, and so on, is inappropriate. It is recommended that the concept of "fitness" replace the image of physical education insofar as it is synonymous with competitive sports. This recommended change in emphasis is not trivial if the college is to substantiate that its point of concern is the individual. Even at the intramural level, there is overwhelming evidence that only a minority of students can physically participate in team sports like basketball or football. Of those students who do participate, again only a tiny minority continue with the sport after college. Yet all students need and most actively desire some opportunity for good health, recreation, and, above all, physical fitness. Therefore, a program is proposed of decentralized, fitness-enhancing facilities related to the learning centers. Multi-use facilities for fitness and recreation should be located near the learning centers, and Brookdale should place emphasis on non-gym spaces which students can use for "drop-in" individual fitness activities."

These concepts were accepted by the Trustees and enthusiastically endorsed by faculty and administration. A "fitness" breakthrough had taken place which owes its genesis to NASA's Division of Occupational Health and Environmental medicine.

Brookdale decided to establish an Advisory Council to the Fitness Learning Center which would create community involvement and assure medical emphasis and controls. The Council is an unpaid voluntary group with an interesting diversity of membership, as follows:

Dr. George H. Sheehan, Cardiologist, Red Bank
Dr. Alden S. Gooch, Cardiologist, Deborah Hospital, Director, Department of Cardiology
Dr. Arthur S. Leon, Cardiologist, Director Special Treatment Unit, Beth Israel Hospital
Dr. Robert J. Alteveer, Stress Physiologist, Hahneman Medical College, Philadelphia
Dr. B. Don Franks, Coordinator, Biokinetic Research Lab, Temple University
Dr. Ken Tillman, Director, Physical Education, Trenton State College
Dr. Tom Tutko, Institute for the Study of Athletic Motivation, San Jose State College

Mrs. Doralee L. Denenberg, Exercise Physiologist, National Health Services, Inc.
Mr. Augustus A. Frank, Jr., Vice President, National Health Services, Inc.
Mr. Leon Zuckerman, B.C.C. Board of Trustees
Mr. Richard P. Kleva, Team Leader, Fitness and Leisure Activities, B.C.C.
Mr. W. P. Johnson, Coordinator, Fitness Learning Center, B.C.C.

The Brookdale Curriculum and Facilities

The curriculum which has evolved from the Fitness Learning Center concept is many faceted. The keystone is the multi-station fitness lab program. The new Brookdale curriculum guide describes their role:

> "After establishing a pre-test routine and an individualized program, participation in the workouts will be determined by the "free time" in the participant's weekly schedule. Our lab hours are 10:00 a.m. to 10:00 p.m. daily. Time spent in workouts at the lab are recorded on time cards. Time clocks are located in each lab. One of the most important factors in the concept of a "walk in" fitness lab is the availability of the facility. Our labs are NOT located in the gymnasium but in the basement of our academic buildings. Each lab is equipped with lockers and showers for both men and women. This frees them from any conflict with our gymnasium, and makes them easily accessible to students between classes. This fits our concept of fitness becoming a realistic part of an adult's life style. Another important consideration was the adoption of the green hospital intern's uniform to replace the traditional gym uniform. This attire lends itself well to the scientific atmosphere as well as providing a serviceable garment for the activities. The public relations aspect of the community fitness lab is vital. Personal fitness like any phase of the educational process must become a part of an individual's life style. To date we in physical education have not accomplished this goal. The blending of physical education and paramedical service to develop tailormade fitness programs for every community will encourage community participants to become involved with adult life activities to maintain fitness levels. This is our goal for the 70's."

The specific exercise stations which were decided upon for these fitness labs are almost identical to the NASA Headquarter's model. They are, in sequence:

1. Treadmill walk for warm-up
2. Speed punching bag
3. Wall pulley weights
4. Rope jump

5. Situps
6. Rowing machine
7. Balance beamwalk
8. Treadmill jog
9. Medicine ball toss
10. Bicycle ergometer
11. Cool-down walk, sauna and showers

Even the time for each exercise station and total elapsed time of about 45 minutes for a complete workout is almost identical to the NASA program.

The program is broadened beyond the NASA model in two interesting ways to accomodate to the College environment.

F I R S T - A FITNESS PROFILE - To be given to all incoming freshmen. It will include the following in addition to medical exams and stress testing:

a. Physical Activity Motivational Inventory - developed by Institute for the Study of Athletic Motivation, San Jose State College and Brookdale Community College.

b. Adult life sport skill tests.

c. Adult life sport knowledge tests.

The results will be used to:

a. Precept students into adaptive fitness programs.

b. Identify any cardiorespiratory health problems.

c. Serve as a challenge to the physical education requirement.

S E C O N D - FITNESS LEARNING CENTER COURSE OFFERINGS - which attempt to provide the students with instruction in many adult life sport skills; for example:

Beginning Swimming
Intermediate Swimming
Swimming and Water Safety
Golf I
Golf II
Bowling
Folk Dance
Modern Dance
Cycling

Personal Fitness
Tennis I
Tennis II
Archery
Departmental Assistant
Fencing
Self Defense
Scuba I
Scuba II
Skiing

The Spreading Impact of the Brookdale Program

Of course, there may be many similar innovations of which we are unaware - however, it is clear that Brookdale will not remain an isolated iconoclast among colleges. Brookdale's first fitness lab will not even open for another month or so - yet some repercussions are already apparent.

1. A special seminar on the Brookdale concept has been scheduled for the November regional conference of the American Association of Health, Physical Education and Recreation.

2. A similar special program is tentatively scheduled for the Association's national convention in Houston, Texas, next March.

3. The Passaic, New Jersey, Community College has included funds in its budget for a program identical to Brookdale's.

4. Professor Johnson and his associates at Brookdale have received many inquiries and requests for guidance from other colleges.

Clearly a process has been set in motion, spawned by NASA, which may very well contribute to a reshaping of physical education throughout the nation. The potential benefits for our country's youth is incalculable.

In all likelihood NASA will get little credit for this additional side benefit of its primary mission. It's a shame!

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AN OPERATING ENVIRONMENTAL HEALTH PROGRAM

by

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Jose G. Lipara, M.D.; Richard L. Masters, M.D., M.P.H., F.A.C.P.M.;
and William R. Winter, M.D., M.P.H., F.A.C.P.M.

Our modern time is characterized by climactic and epoch making events. Our monumental achievements in technology and our phenomenal progress are unprecedented in man's recorded history. In just a short time span, we have progressed from the age of industrial revolution to the atomic age, and with a "giant leap" to the space age. The rapid succession of scientific advancement has necessitated an equally rapid social change. As innovation in our society accelerated, the impact of this "progress" on demography and occupational structure was inevitable. We have created a new society more sophisticated and prosperous as the result of the cumulative effects of new discoveries. However, the fact that the frontiers of knowledge have been pushed and expanded beyond the previous limits does not in itself insure a better world. Despite the wonder of these achievements, progress has brought with it health hazards and inherent health problems.

Health has many different meanings to many people. Health has been defined by the World Health Organization as "a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity." We prefer this definition, since it embodies a utopian desire which can be fulfilled, but only by the absolute commitment of man's total resources

and those of his environment. It is, however, challenges of this sort that have brought us to the threshold of a new era in medicine.

In recent years, with accelerating social change, there has been an increasing interest in health, and on a much wider scope, in ecology. These areas have now become a national preoccupation. The issue of ecology invariably nurtured the cropping of a variety of experts, variously called ecologists, environmentalists, and antipollutionists. Since the practice of industrial medicine is essentially an element of environmental medicine, the occupational medicine physician must make his influence felt in the area of environmental medicine if we are to maintain our rightful position in the medical hierarchy. Let us divert for a moment to define environmental medicine as that branch of medicine dealing with the health effects of the interaction of the human body and the total environment. It has interrelated areas of interest, and, its study must, necessarily, involve an interdisciplinary and multidisciplinary approach. It is difficult to trace the development and emergence of environmental health and environmental medicine, since it has risen from so many interrelated disciplines, such as physiology, with its investigations in hypobaric and hyperbaric effects, hypoxia effects and biorhythms, and many other areas of study. We cannot overlook the contribution of occupational medicine to the development of the more global concept of environmental medicine. Certainly, environmental medicine has been in large part stimulated in its development by the studies and pursuits of environmental medicine specialists in attempting to help man cope with adverse effects of his environment. The occupational medicine specialist was among

the first to realize that we could not always change the environment, but rather must in some way attempt to protect man from the environment.

In the past, industrial health maintenance programs have been able to cope with industrial health needs. Vast knowledge was gained and industrial medicine has become a specialized discipline. It has been recognized as a medical specialty, but not without tumultuous emotion from the profession. Among other things, the practice of industrial medicine in Government, or in private industry, often elicits in the mind of the physician and the layman a kind of dubious activity. The practitioner of industrial medicine is frequently looked upon by other practitioners as one who does physical examinations, applies bandages, and dispenses aspirin. Too often occupational medicine is looked upon as a retired physician's job, with some level of scorn from the private sector of medicine. Through exemplary achievements some specialists are able to extricate themselves from this predicament. Few rise above reproach but if they do, they are considered out-and-out competitors to private practitioners, if not a formidable enemy. These untoward emotions are still persisting today. Although our motives are altruistic and our activity complimentary to other practices of medicine, it is pathetically misunderstood by so many. As with other areas of preventive medicine, industrial medicine is devoid of drama and is less well understood by society, although it may have impact on a single individual or profund implications for the entire population.

Conventional practices of industrial medicine in the past have adequately served the purposes of their time. Notwithstanding the meritorious

and inspirational achievements of the past we cannot, in blind complacency of past laurels, remain static if we are to meet our responsibility and the challenge of our time. In the world of change we must be pliable in spite of the arbitrary rigidity of our ethical confinement. The confines of industrial medicine will be broadened inevitably, to fulfill the need and demand of our time; with or without our volition, and by legislation if necessary from the pressures of the working population. The practitioner of occupational medicine must accept, to some degree, his failure to meet the responsibilities that he has had to the consumer of medical care in a constantly changing relationship between health providers and patients. The public has been educated to expect miracles of preventive medicine, and the public is disappointed when they see so little done by the medical profession in their ordinary practice. Hence, the occupational medicine physician can and must assist the general medical profession by adding some elements of the practice of preventive medicine for employees. Cost effectiveness is a concept which has been widely exploited, but it is a useless concept in the evaluation of preventive medicine programs. It is useless simply because we have passed to a high level of sophistication in the consumer and the consumer is demanding, and will receive, as we stated before through legislation if necessary, the type of practice that he has been educated to expect.

We have just scratched the surface of the many problems that besiege the practitioner of environmental and occupational medicine. There are many more, but we are not here to discuss the philosophical boundaries of medical

practice. In the light of current knowledge of some of the problems mentioned above, we at the NASA Flight Research Center designed our health maintenance program, insofar as possible, to meet some of these responsibilities and problem areas. It is the purpose of this report to present the concept of our operational program.

Fig. 1 outlines the medical and environmental health program being conducted at the NASA Flight Research Center. The separation of these elements of the program is artificial and is intended for descriptive purposes only; in actuality all elements are interacting, each bein interdependent on the others for the successful operation of the program. Details of the program are to be found in the "Guideline of the Occupational and Environmental Health Program" conducted for the NASA Flight Research Center, Edwards, California.

The area of medical services deals primarily with emergency care. Definitive diagnoses and extensive therapy are not within the scope of this program; these fall within the jurisdiction of the patient's private physician. Minor illnesses or injury receive emergency care. The treatment is intended to provide the relief of pain and suffering for the patient and to diminish time consuming absences from work. Whenever possible we obtain laboratory examinations such as roentgenograms, electrocardiograms, blood studies, and other diagnostic procedures that are within our capability. With the patient's consent we advise his private physician of the nature of the patient's problem and supply him with the pertinent medical findings which have led to a working diagnosis. When necessary, we diplomatically

offer suggestions. We make extra effort to establish good rapport with the private physician. So far we are succeeding. This rapport helps to bridge the gap of our total medical care, circumventing the previously mentioned problems with the private physicians considering us to be in competition. In order to complement the services of the private physicians to their patients, we do perform medical monitoring activities such as blood pressures, dynamic electrocardiography, blood chemistries, etc., which may aid him in managing his patient's medical problems. Always, these are upon specific request and with the physician's consent. This further improves our working relationship with both the physician and the patient. In general, both are grateful to have this capability at their disposal. We recently had a patient whose diagnosis involved coronary heart disease with a history of fainting and irregular heart action. His resting electrocardiogram was borderline, as shown in Fig. 2. The top tracing shows his resting electrocardiogram. He was placed on antiarrhythmic medication by his physician. Dynamic electrocardiography of 8 hours duration, while at work, revealed a paroxysmal arrhythmia, as can be seen in the middle tracing. The bottom tracing shows the improvements after proper titration of the medication.

Our major therapeutic armamentarium may be no more than a lending ear, employing the time honored therapeutic effect of sympathetic listening. It is remarkable how infrequently we need to dispense drugs. It is unfortunate that listening is becoming a dying art, especially at this time when society is fast becoming more and more drug dependent. Patients somehow conceive the idea that there is a pill for every vicissitude of life. Through medical

counseling, we established a patient-physician rapport. Here, we are bordering on a very sensitive area dealing with some of the arbitrary boundaries previously mentioned. But, can we really be of service and fulfill our commitment and our obligations to our patient without this relationship? This is something to ponder in a quiet moment.

The preventive medicine aspect of our program deals with those activities which promote and safeguard the health of the individual employee. The methodology is traditional, essentially following the fundamental principles and practices of preventive medicine. However, we frequently cross into the other aspects of our program, for example, from medical service to research. As a departure from the conventional health evaluation program, we disregard the usual division of executive and routine physicals. We only do comprehensive medical evaluations. Disease recognizes no social hierarchy, and neither do we. In addition to comprehensive periodic examinations, health maintenance examinations also include pre-employment, preflight, flight, placement and postillness examinations.

We believe that each individual is definitely a significant part of the total environment, call it ecology if you wish. The content of our medical evaluation is presented in Fig. 3. We are strong proponents of physical fitness and we advise all of our employees to have regular exercise. We optimize their exercise program by periodic physical competence testing; the testing is done in the physiology laboratory pictured in Fig. 4. Our equipment consists of a bicycle ergometer and the necessary electronics. The procedures are similar to those done in Dr. Luft's physiology laboratory at

the Lovelace Foundation in Albuquerque, New Mexico. Briefly, the test is a maximal exercise tolerance test with progressive step-wise increases in load. For the first three minutes the load is held constant at 50 watts, thereafter the load is increased by 12.5 watts every minute to the maximum load the subject can tolerate. The end point of the test is tabulated in Fig. 5.

The physiologic parameters monitored are shown in Fig. 6. The first four of these parameters are continuously monitored and recorded on magnetic tape. The last three parameters are obtained using Douglas bag collection at predetermined times. The first collection is usually at 7 to 8 minutes; the last three collections are at maximal exercise. The oxygen uptake at maximum exercise is our "index of fitness." By using the maximum oxygen uptake we can inform the subject of his fitness status and advise him accordingly in order to optimize his exercise regimen. Even though the test is relatively safe, with proper precautions, the personnel in the laboratory are trained in resuscitation techniques and the necessary equipment from defibrillator to drugs is ever ready to meet any eventuality.

The environmental health activity at the Flight Research Center provides medical support and advisory resources for solving problems relating to the work environment and other environmental hazard areas. The service includes the conducting of surveys of potential or already existent health hazards within the Center. Health surveys and follow-ups are conducted semiannually and on an as-needed basis. Consultations are provided on specific environmental health problems as the need arises. All work areas at the Flight

Research Center are inspected and evaluated for environmental health problems. The evaluation includes analyses of the adequacy, availability, and sanitation of the various sanitary and eating facilities; heating, cooling and ventilation requirements; adequacy and suitability of lighting to prevent eyestrain and promote comfort; insect and rodent control; sanitation and waste disposal; noise evaluation in offices, hangars, test cells, etc., including evaluation of the adequacy of noise control and possible elimination of noise sources, as well as a hearing conservation program; evaluation of proper use, handling and disposal of toxic materials; adequacy and suitability of protective equipment; type, amount and safety precautions regarding air contamination and personal protective measures; handling, use and disposal of radioactive materials, when used; evaluation of X-ray, microwave and laser health hazards; determination of physical hazards and potentially or actually dangerous work conditions in the environment; and other areas as determined by specific situations.

Research efforts pertaining to the occupational and environmental health program are primarily directed toward clinical and environmental studies. Research effots are confined to studies on informed volunteer subjects and do not involve the use of drugs, medications or hazardous procedures which could jeopardize the health of the subjects. The research efforts include, but are not limited to, epidemiological studies (both cross sectional and longitudinal) of heart disease, cancer, stroke, etc., as they pertain to the Center employees; physiologic stress, noise phenomena; dynamic electrocardiography including monitoring during daily and home activities; and psychophysiologic studies.

For some years, the NASA Flight Research Center has sponsored the training of a resident in his final year in the specialty training in aerospace medicine. The aerospace medicine residency training program is conducted by the Department of Aerospace and Environmental Medicine at the Lovelace Foundation, under the auspices of the Ohio State University. The third year is the final year in the program offered to residents at Ohio State University. Six months of the residency training takes place at the Lovelace Foundation in Albuquerque, 6 months of the residency take place at the Flight Research Center. The residency training program is specifically tailored to the individual requirements of each resident and to his desires for future career opportunities. The occupational medicine and environmental medicine aspects of our program and the aerospace medicine research being conducted at the Center provides the resident with important operational experience.

A word must be said about multiphasic health screening tests. The great strides of technology which we have seen over the past few years have given impetus to automation and to the use of multiphasic screening tests. In our program, however, we have not yet embarked on the use of multiphasic screening tests. We feel that multiphasic screening is a superficial shortcut approach to substitute a level of noncare for basic good practice of medicine. It side-steps the laying on of hands in the name of time saving. We do not feel that multiphasic screening can or should be elevated to the level of a substitute for good medical evaluation. There is, we believe, no sound basis for exploiting the use of multiphasic screening as a substitute

for a basic, sound program of good occupational medicine. Of the serious diseases which have been discovered as a result of the program just described which has been in operation at the NASA Flight Research Center for the past year and a half, only a few of the diagnoses would have been suggested by the common multiphasic screening tests now in use. Multiphasic screening is expensive and can lull both physician and patient into a totally unwarranted sense of false security. Currently, much of the promotion of multiphasic screening is coming from organizations which are not medically sophisticated and which have little or no physician input. These organizations propose a system which provides a superficial approach to a deep and basic problem of medical diagnosis and which can be time consuming, expensive and totally misleading in its results.

The program conducted at the NASA Flight Research Center is presented with no claim for panacea. The program's orientation is toward overcoming some of the intricacies of the problems that we have discussed above. Flexibility of action must now and forever be the key word in evaluation and continuing development of occupational medicine programs. There is now more than ever an urgent need for further exploitation of all available methodology and tools of preventive medicine, as long as these tools do not represent a substitute for good medicine. Also, we must turn our efforts to the study of the effectiveness of the programs and the various proposed programs around us. Through a systematic approach applying the "system philosophy" and formulation of "models" efforts may be optimized and alternative methods of exploration may be uncovered.

In summary, the real and apparent problems that besiege us have been presented. The practice of an environmental medicine program has been presented as it pertains to the NASA Flight Research Center. In Fig. 7 we can see these guidelines which have been used for the health maintenance program. These are as follows:

A. Comprehensive medical care.

B. Prevention and possibly prediction of adverse health condition.

C. Periodic intensive medical evaluation.

D. Emphasis on physical fitness.

E. Periodic physical fitness evaluation.

F. Epidemiological studies.

G. Research on work stress.

H. Continual reappraisal of our efforts.

I. Continual reevaluation of our methodology.

NASA-FLIGHT RESEARCH CENTER
MEDICAL AND ENVIRONMENTAL HEALTH PROGRAM

A. Medical Services

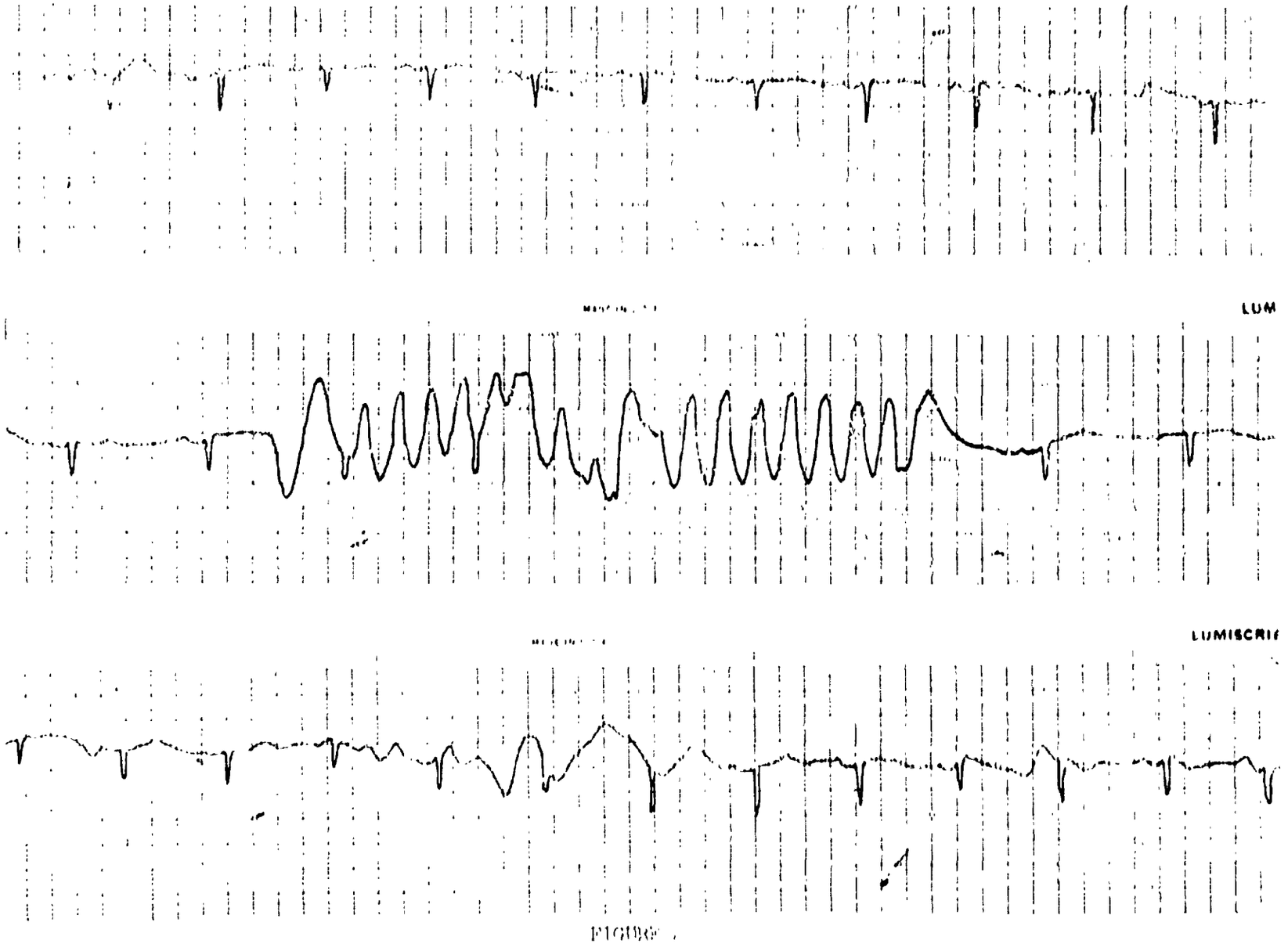
B. Preventive Medicine

C. Environmental Health

D. Research

E. Education

FIGURE 1



FIGURE

MEDICAL EVALUATION

A. Complete medical history

B. Physical examination including

- Ophthalmoscopy
- Tonometry
- Vision testing
- Audiometry
- Indirect laryngoscopy
- Proctosigmoidoscopy
- Pap smear

C. Neurological examination

D. Laboratory examinations

- Urinalysis. pH, Specific Gravity, Albumin, Sugar, & Blood
- Blood Chemistry Glucose, Urea Nitrogen, Uric Acid, Cholesterol, Total Protein, SGOT, LDH, Alkaline Phosphatase, Inorganic Phosphorus, Calcium, Total Bilirubin.

E. Electrocardiogram

F. Roetgenograms. Chest X-ray usually

G. Pulmonary function studies Spirometry and N_2 washout

H. Physical competence test Bicycle ergometry

I. Other tests as clinically indicated

FIGURE 3

NASA

E-23541

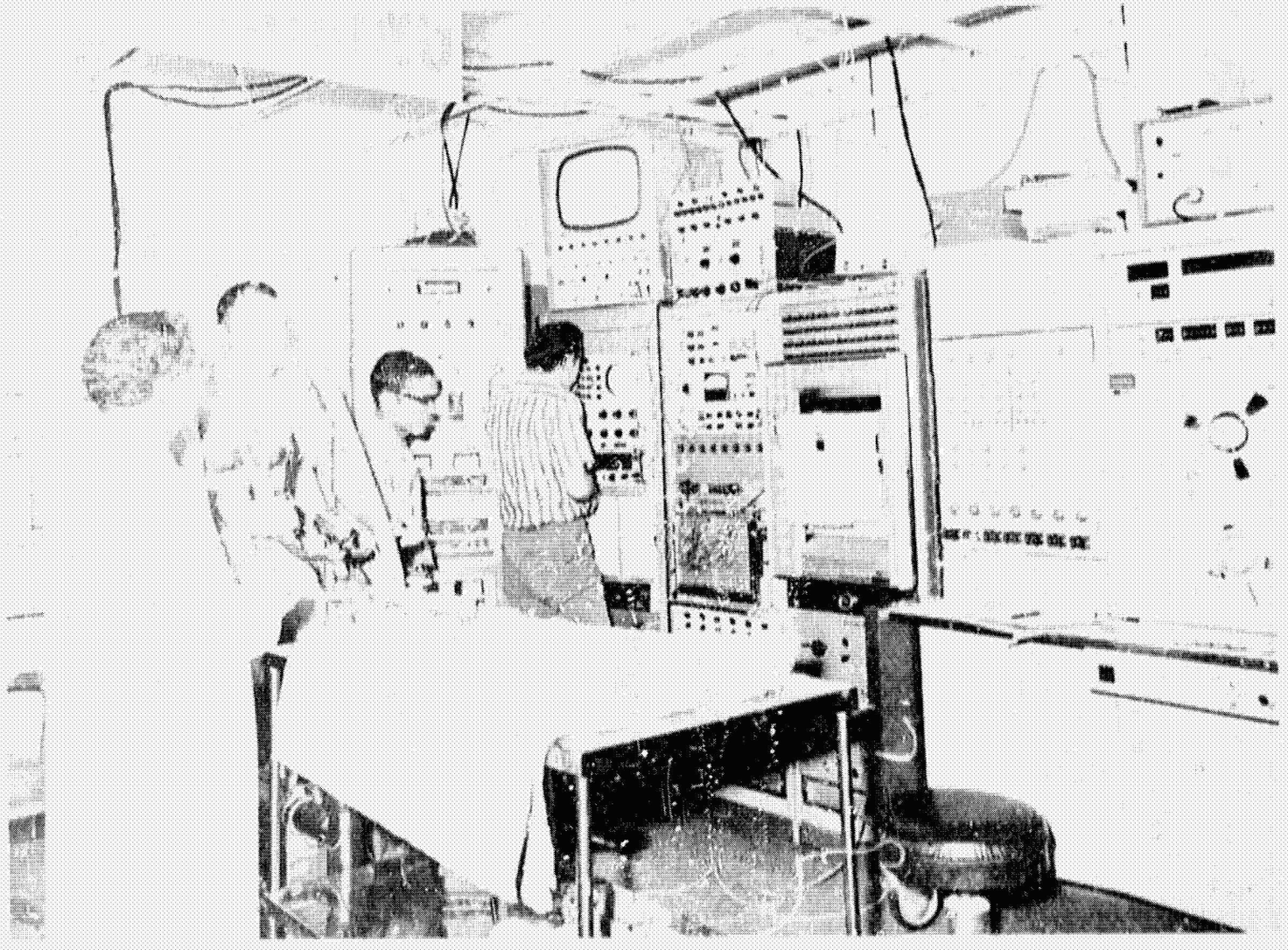


FIGURE 4

Flight Research Center
Edwards, California

END POINT OF THE TEST

1. Adverse symptoms such as chest pain, cramps, dyspnea, etc.

2. Abnormal signs such as cyanosis, pallor, unduly elevated blood pressure, etc.

3. Fatigue.

4. Inability to maintain a regular pedaling rhythm (50 rpm).

5. Deemed inadvisable by the physician in attendence.

FIGURE 5

PHYSIOLOGICAL PARAMETERS

1. Heart Rate
2. Electrocardiogram
3. Blood Pressure
4. Respiratory rate
5. Respiratory volume
6. Oxygen uptake
7. CO_2 production

FIGURE 6

GUIDELINES OF THE HEALTH MAINTENANCE PROGRAM OF THE NASA FLIGHT RESEARCH CENTER

A. Comprehensive medical care

B. Prevention and possibly prediction of adverse health condition.

C. Periodic intensive medical evaluation.

D. Emphasis on physical fitness.

E. Periodic physical fitness evaluation.

F. Epidemiological studies.

G. Research on work stress.

H. Continual reappraisal of our efforts.

I. Continual reevaluation of our methodology.

FIGURE 7

N73-17094

NEW STANDARDS FOR ULTRA VIOLET RADIATION

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NEW STANDARDS FOR ULTRAVIOLET RADIATION

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Recent studies of ultraviolet biologic effects have clarified the spectral radiant exposure doses and relative spectral effectiveness of ultraviolet radiation required to elicit adverse biologic effects.

Until the advent of the laser, the principal hazard problem recognized in the use of optical sources was the potential for injury of the skin and eye from ultraviolet radiation at wavelengths less than 320 nm[1]. The high attenuation afforded by many optical materials in the 200-310 nm spectral range generally encouraged an empirical approach of enclosing the optical source with glass, plastic or other material having high absorptance values below 320 nm. If injurious effects developed in the eye or skin of individual users, the source enclosure was increased in thickness.

The photochemical effects of ultraviolet radiation upon the skin and eye are still not completely understood. However, the relative spectral effectiveness of radiation in elliciting a particular biologic effect, refered to by photobiologists as action spectra, are generally available. The steep slopes of ultraviolet action spectra are quite impressive and should demonstrate the importance of not blindly extrapolating biologic data developed from one wavelength to another or assuming that already familiar photochemical absorption bands do not have fine structures. The inevitable development of a wavelength-tunable

laser source in the ultraviolet region will provide a dramatic new tool for ultraviolet photobiology by making a dramatic increase in spectral irradiance over that afforded by present ultraviolet sources. The CIE Committee E-2.1.2 has developed spectral band designations in the near ultraviolet spectrum which are quite useful in discussing the UV biologic effects. They designate 315-400 nm as UV-A, 280-315 nm as UV-B, and 200-280 nm as UV-C.[2]

ULTRAVIOLET EFFECTS ON THE SKIN

A sufficient exposure to actinic ultraviolet radiation results in erythema or reddening of the skin (e.g., sunburn). The action spectrum of ultraviolet erythema was investigated by several teams of physical scientists in the 1920's and early 1930's.[3-6] Figures 1 and 2 illustrate some of the key findings of Hausser and Vahle which are generally summarized by only one graph of a "standard" action spectrum in most texts. All of these investigators explained the importance of noting the length of time after exposure for the various degrees of erythema to develop and the value of defining the action spectrum at a well-defined degree of redness and not at the "just perceptible" erythema. They all chose to work with exposure doses above those where the highly transitory erythema produced by UV-C played a significant role.

Recent dermatological investigations have found the action spectrums for this just-perceptible erythema to be quite different from the "classical" curve, which is not at all surprising.[7-9] Erythema thresholds vary significantly with skin pigmentation

(over at least one order of magnitude). Erythema thresholds may be as great as a factor of ten or more for very dark skin than for very light caucasian skin, with skin of intermediate pigmentation having thresholds in between. Clearly the action spectrum of interest depends upon the application. In applying an action spectrum to the development of hazard criteria for industrial exposure one must make a judgment of what exposure limits will result in unwanted acute and chronic effects. Erythema production for a given spectral source is dependent only on the total dose; reciprocity exists between exposure rate and exposure duration over a wide range of exposures (<0.01 s to several hours).[10]

Chronic exposure to ultraviolet radiation accelerates "skin aging" and it is now generally felt that such exposure increases the risk of developing certain types of skin cancer.[11-12] Since UV-B penetrates more deeply into the skin than radiation in the rest of the actinic ultraviolet spectrum, it has been thought to be the most effective in affecting living tissue as is attested by its capability of producing the more severe grades of erythema. Several epidemiologic studies of skin cancer incidence reveal a very strong correlation with terrestrial solar UV-B levels found at given latitudes and ground elevations.[11-14]

A quantitative threshold for carcinogenesis by ultraviolet radiation appears to be very difficult to define if indeed one exists. Epidemiologic studies correlating solar ultraviolet

exposure with skin cancer may shed some light on whether quantitative thresholds exist for human skin cancer but such studies could only place some quantitative limits on a "threshold value."

It should be mentioned that some rare individuals are hypersenstitive to irradiation from specific optical spectral bands and may develop skin reactions described as "photosensitivity" following sub-erythemal exposure.[15-16] However, in the industrial environment it would be highly unusual for the symptoms of photosensitization to be elicited solely by a limited emission spectrum from industrial light sources such as "black light". Sunlight usually will also elicit or aggravate this skin response.

ULTRAVIOLET RADIATION AND THE EYE

Regarding the visual spectral sensitivity of the human eye, the retina responds to near ultraviolet radiation as to light; however, the lens of the eye is a strong absorber of wavelengths shorter than 400 nm and the resultant spectral sensitivity for vision markedly decreases between 420 and 380 nm.[17]

UV-B and UV-C radiation are absorbed in the cornea and conjunctiva, and in sufficient doses will cause keratoconjunctivitis, that painful effect known to most as "welder's flash." The action spectrum and threshold dosage of ultraviolet keratoconjunctivitis have been investigated by several groups. General agreement may be found in the results of the different investigators if the differences in experimental techniques, instrumentation, and subjects are considered. Of the published studies those particularly

relevent to human exposure were recently completed upon primate eyes and some human eyes by Pitts and his collaborators.[18] Using an arc monochromator, they obtained data for 10 nm bands between 320 nm and 200 nm. They found the peak of the photokeratitis action spectrum at the 265-275 nm band and a threshold at that wavelength of approximately 4 $mJ \cdot cm^{-2}$ for both human and primate eyes. This is somewhat different from the earlier studies of Cogan and Kinsey[19] who found a peak in the action spectrum at 288 nm using a low-pressure-mercury-arc monochromator with narrower wavelength bands. The reciprocity of irradiance and exposure duration probably holds for time periods similar to those which hold for ultraviolet erythema of the skin. These studies did not reveal an action spectrum for conjunctivitis different from keratitis. The action spectrum of Pitts is given in Figure 3 (solid line histogram) with the approximate range of thresholds at each band (I). Unfortunately, this action spectrum when weighted against the ultraviolet spectrum of indirect daylight to which the eye is daily exposed would indicate that almost everyone would develop keratoconjunctivitis in a few hours while standing outdoors. This would indicate that the investigators had experimental difficulties in accurately determining the obviously extreme slope of the action spectrum in the 300-315 nm range. It also demonstrates that thresholds which were averaged over 10 nm intervals weighted against a source spectrum rapidly increasing in this region can lead to error since sufficiently narrow

wavelength intervals could not be used. Individuals do develop [illegible]conjunctivitis from daylight ultraviolet radiation but only after prolonged exposure to ultraviolet reflected from snow (an aspect of snow blindness). Snow is essentially the only material found in the natural environment with a high reflectance in the actinic ultraviolet spectral region; water reflects very little and transmits a large percentage. Accidental exposures to ultraviolet radiation from germicidal lamps[14] (which emit principally at 253.7 nm) indicate a human threshold for photokeritis of approximately 10 mJ-cm^{-2}—in close agreement with the data of Pitts.

GUIDELINES FOR OCCUPATIONAL EXPOSURE TO ULTRAVIOLET RADIATION

At the present essentially no quantitative occupational exposure standards exist in this area. Factors contributing to this situation are (1) the difficulty of performing accurate spectral irradiance measurements in this spectral region, (2) the limited number of optical radiation sources which emit significant actinic ultraviolet radiation, and (3) the ease of using protective eyewear and clothing which have enormous attenuation factors for actinic ultraviolet.

In one application—the use of germicidal low pressure mercury lamps which emit principally at one wavelength (254 nm)—exposure limits have been promulgated. The Council on Physical Medicine of the American Medical Association proposed a limit of

0.1 $\mu W \cdot cm^{-2}$ for a 24-hour exposure and 0.5 $\mu W \cdot cm^{-2}$ for a 7-hour or shorter exposure to these lamps.[21] These values were based upon a minimal erythema dose of 32 $mJ \cdot cm^{-2}$ delivered in a 15-minute exposure at 254 nm. A greater than apparent safety factor actually exists for the long exposure times of 7 and 24 hours since there is some loss of dose reciprocity for such long exposures.

If one can accurately determine the spectral irradiance vs. wavelength of a source (a non-trivial task in the UV region), this spectrum may be weighted against an action spectrum for each biologic effect of interest to determine if a potential hazard exists. A somewhat simplified approach is, however, possible. If the threshold data for acute effects obtained from the recent studies of minimal erythema and minimal keratoconjunctivitis are combined upon one graph (figure 2), one may draw an envelope curve which does not vary significantly (in comparison with measurement errors and variations in individual response) from the collective threshold data. Since repeated exposure of the eye to potentially hazardous levels does not result in increasing the protective capabilities of the cornea (as does skin tanning and thickening which increases the protective shield for the deeper skin tissue) the preceding exposure guide is more readily applicable to the eye and should be considered as a limiting value for that organ. However, such a guide can only be a starting point for determining skin exposure since wide

variations in actual thresholds exist among individuals, and the threshold varies with exposure history for a given individual. Such a guideline would have a built-in safety factor for essentially all but very sensitive individuals. The magnitude of the safety factor would depend upon the spectrum of the source since at least two independent action spectra (e.g., the 300 nm vs. the 254 nm bands for erythema production) may exist and would not be additive.[22-23] Sources such as the sun which have a rapidly increasing spectral irradiance in the 300-315 nm band would be difficult to accurately evaluate using this or any other exposure guideline. The guideline could be applied only with extreme caution to ultraviolet lasers since all the biologic data upon which it was based were obtained from relatively broad-band sources. Theoretically, narrow absorption peaks of an appropriate chromophore, if located at a laser wavelength, would drastically change the action spectrum. However, these narrow peaks would not be expected for such large organic molecules. Such an exposure guideline is clearly non-applicable to photosensitive individuals since the action spectrum is likely to be significantly different and extend well into the UV-A or visible region. The Committee on Physical Agents of the ACGIH recently set a tentative threshold limit value (TLV) based upon this envelope concept (figure 3 - dashed line) and is given in table I.[24] The formula required for determining permissible exposure time t

(in seconds) from a broad-band ultraviolet source, for which the spectral irradiance is known, is as follows:

$$t = \frac{0.003\ J \cdot cm^{-2}}{\sum E_\lambda \cdot S_\lambda \cdot \Delta\lambda}$$

where E_λ is the spectral irradiance in $W \cdot cm^{-2} \cdot nm^{-1}$, S_λ is the relative spectral effectiveness (unitless), and $\Delta\lambda$ is the band-width in nm. Hopefully, the development of an inexpensive instrument will be encouraged by this type of TLV such that spectral irradiance measurements will not be required to evaluate an ultraviolet source.

Guidelines for limiting exposure of individuals to near ultraviolet (UV-A) radiation can be based on relatively little data, and are seldom required since few sources emit sufficient radiation limited to this spectral region to create any adverse biologic effects to normal individuals. Effects upon the skin are considered to be principally thermal, and guidelines applicable for skin exposure to far infrared radiation (10 to 100 $mW \cdot cm^{-2}$) would appear to be applicable without problems except, of course, for photosensitive individuals. However, few sources including the sun are capable of producing irradiances above 1 to 5 $mW \cdot cm^{-2}$ in the 315-380 nm band under typical conditions. Guidelines for ocular exposure are quite a different matter. The suggestion of near ultraviolet radiation playing a causitive role in cataractogenesis has not been sufficiently investigated.[25-26]

Short-term (16 minutes) laser exposures to a rabbit eye at 325 nm have produced cataracts at a corneal irradiance of 0.65 $W \cdot cm^{-2}$ (10 mW in a 1.5 mm beam)[27]. One investigator reported the experimental production of cataracts at 297 nm which seems quite unlikely.[28] What levels below this could create any lenticular opacities under chronic exposure conditions are unknown. There are no strong indications that the low levels of this radiation found in industrial environments present a problem, although it has been suggested as the causitive agent in glass-blower's cataract in the past.[25] If concern exists in any situation, ultraviolet goggles designed to prevent the annoyance of lens fluorescence for individuals working with "black light" provide considerable protection from UV-A.

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TABLE I
PROPOSED 1971 THRESHOLD LIMIT VALUE FOR
EXPOSURE TO ACTINIC ULTRAVIOLET RADIATION

Wavelength (nm)	TLV ($mJ \cdot cm^{-2}$)	Relative Spectral Effectiveness S_λ
200	100	0.03
210	40	0.075
220	25	0.12
230	16	0.19
240	10	0.30
250	7.0	0.43
254	6.0	0.5
260	4.6	0.65
270	3.0	1.0
280	3.4	0.88
290	4.7	0.64
300	10	0.30
305	50	0.06
310	200	0.015
315	1000	0.003

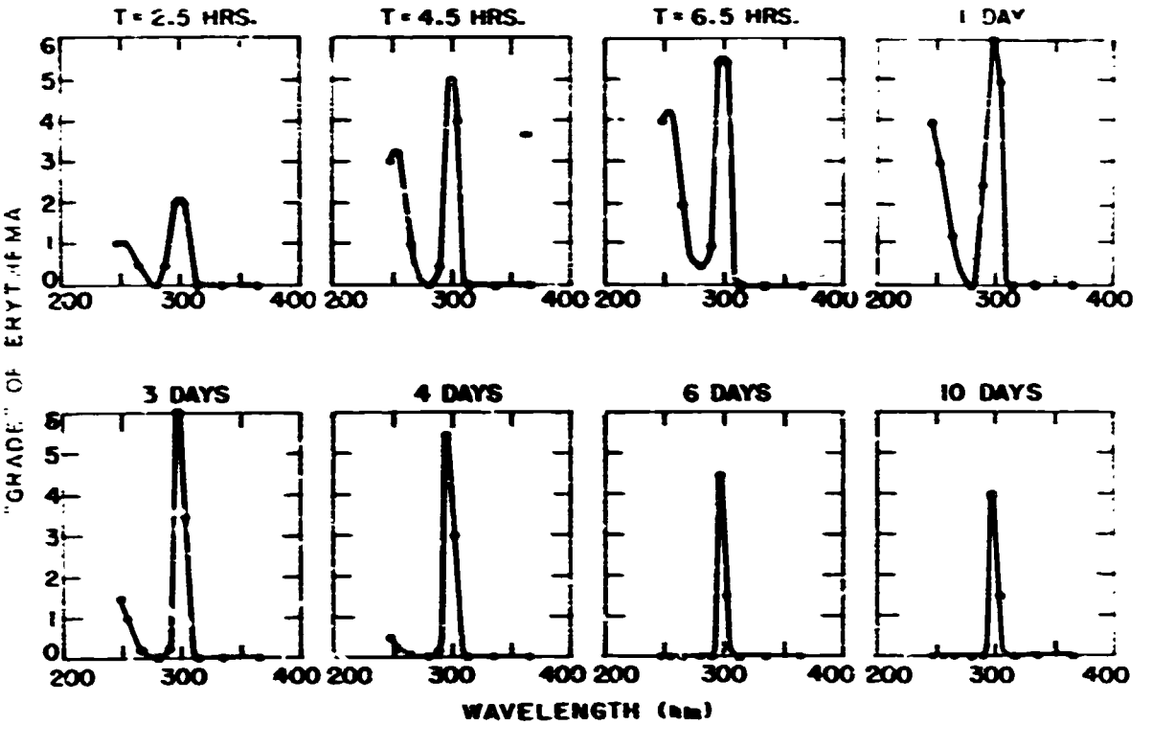

Figure 1. The time course of moderate ultraviolet erythema. Ultraviolet erythema action spectra obtained by Hausser (1928) for eight different observation times[3].

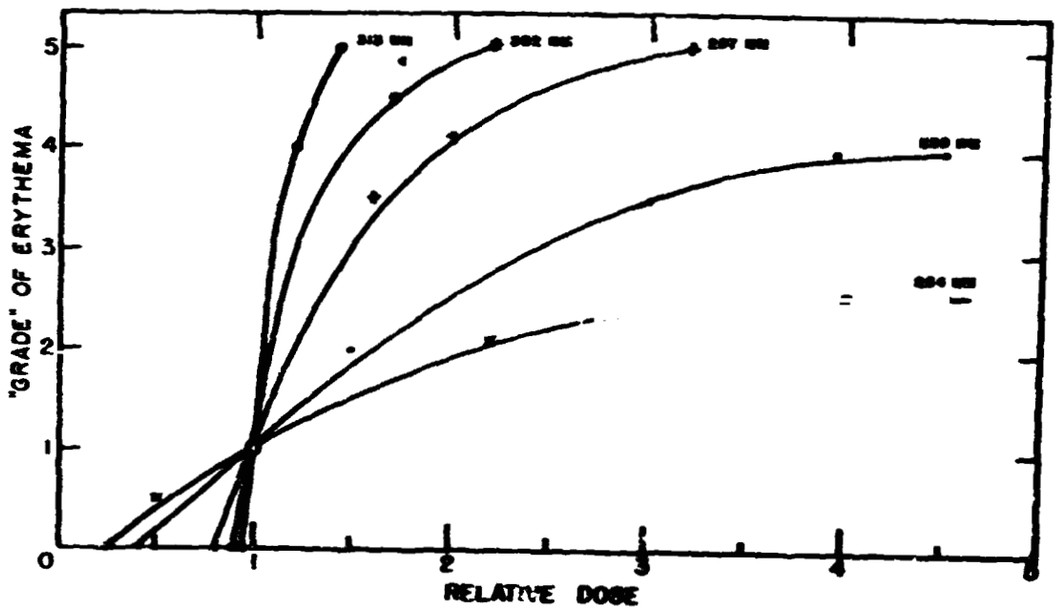

Figure 2. The degree, or "grade", of erythema (skin reddening) for increasing dose obtained by Hausser[3]. He noted that the monochromatic UV-B radiation which penetrated more deeply into the skin than UV-C radiation was far more effective in producing serious erythema (as well as longer lasting tan). Hausser's grading system consisted of a comparisan of skin redness with a logarithmic density scale obtained with red dye solutions. An erythema grade of one was above minimal erythema.

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N73-17095

HAZARD PAY

AN EFFECTIVE ANTAGONIST

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The playwrights have often called our attention to an insidious type of villain who seems on the surface to be a valued and useful agent to the protagonists, but is in fact a dangerous threat to their well-being. The malignant Iago, as he led Othello to murder his innocent wife, is perhaps the best known example. There is, however, a special variety of these villains who are dangerous enough, not because they are consciously evil, but because of powerful forces working within them that are a little beyond their control. To my mind, Lancelot is the most intriguing among these.

In the non-fictional drama of occupational health protection, hazard pay has a role not at all dissimilar to Sir Lancelot's. As Camelot came crashing down upon his shoulders, perhaps it occurred to King Arthur that a timely orchidectomy would have preserved his "brief shining moment." And Arthur could have done it! On the other hand, hazard pay for Federal workers is required by Congress and, therefore, is much more firmly entrenched than Lancelot was. Hazard pay is not likely to be emasculated. Therefore, to protect our Federal health and safety programs, we must devise for them an effective chastity belt.

At first glance, hazard pay would seem to be a perfectly harmless way to reward a worker for taking risks that other workers do not have to take. No one objects to regular high pay for test pilots, so why

[illegible] fearful of small differentials paid every once in a while to a [illegible] employee who is asked to do something unusual and risky?

The problem begins with a concept which may be stated as follows: [illegible], hazards, dangerous, can be adequately safeguarded if sufficient [illegible] are spent on the problem. This concept has terrific impact on the hazard [illegible] because it introduces two factors that are difficult to deal with -- judgment and morals. We can start with a dangerous task and add one safeguard after another until the danger essentially disappears. In many cases, however, to do so would cost so much that the entire project would be abandoned instead. Therefore, the actual objective is usually not to eliminate hazards, but to reduce them to some acceptable level. The level that is acceptable, and the capability of the safeguards to provide this level, are matters of judgement. Since we can achieve a degree of safety commensurate with the amount of money we are willing to spend, it follows that we can achieve a slightly inadequate degree by spending not quite enough. Difficult decisions of this nature arise virtually every time a facility or major system is being designed, and safeguards must compete with operational requirements under a fixed budget. Morals enter the picture the first time someone considers paying a hazard differential, which would come from some other budget, rather than providing a full complement of safeguards.

Another moral question arises when the time comes to consider a dangerous task that, for all practical purposes, can not be adequately safeguarded, i.e., even the minimal acceptable safeguards would cost too much. When that happens, the real issue is whether the task should be

[illegible] is not essential, it should not be permitted. [illegible] there is any to accept, but the actual decision [illegible] may be extremely difficult to make. From a strictly moral [illegible], the decision should be made without considering special pay as [illegible] the fact that a worker can receive extra money for a dangerous [illegible] influence a marginal case.

[illegible] from the temptations created by hazard [illegible] piece of work may then be taken, so much so [illegible] that, he expected to avoid hazardous work if he must [illegible] pay. That is particularly true of young males who [illegible] of themselves as indestructible. Hazard pay, then, has the [illegible] the worker's normal fear of danger as well as [illegible] tendency to accept safe working conditions. I observed this [illegible] at the Argonne Nuclear Research Center in Greece, where employees [illegible] hazard pay for exposure to radiation. The higher the exposure, as measured by a film badge, the higher the pay. Needless to say, exposures ran high. The smart ones took their badges off and surreptitiously [illegible] their own radiation sources. I don't have to tell you how the others [illegible] their exposures.

There is only one way that a situation like this could be worse. That would be to have the radiation protection officer administer the hazard pay program, and that is exactly how it was done in Greece. Consider the position of any health protection or safety officer as he performs his routine duties. As a staff employee, his effectiveness is dependent for the

[illegible] depend upon the degree of cooperation he can obtain. Frequently, however, he must interfere in some manner with work, and this interference, although necessary, is not often welcomed. Thus his relationship with employees is critical and rather delicate. If he is assigned the responsibility of deciding whether or not a worker will receive extra pay for taking chances, he must either upset the delicate balance by saying no and taking money out of the worker's pocket, or he must say yes, admitting that the protective program is faulty, and that it either cannot or will not be fixed, and, even worse, that the task will be performed anyway. Decisions regarding the practicality of a dangerous task and whether to grant the necessary pay for safeguards do not belong to a safety or health specialist. Their job is to specify what safeguards are required to achieve an adequate degree of protection. To involve them further in a hazard pay program would be inappropriate.

In summary, these are the charges against this seemingly benign antagonist:

(1) Pay may be substituted for safeguards.

(2) Duties which should be prohibited may be authorized under a premium pay justification.

(3) Employees may perform work under hazardous conditions unnecessarily in order to receive premium pay.

Since we can not eliminate hazard pay, what shall we do to protect our federal health and safety programs from compromise?

Perhaps a sound beginning would be to acknowledge that it is sometimes necessary to consider the performance of work that is hazardous but for which adequate safeguards would not be practicable, to recognize these situations as the critical ones requiring our attention, and to raise no objection to premium pay for such work if the proper decisions are made beforehand, in a competent manner, and by the appropriate officials. The critical decisions are :

(1) that the provision of adequate safeguards is in fact not practicable;

(2) that the task is in fact essential.

If we can assure that these decisions are properly made before hazard pay is authorized, payment would never be made unless an employee is requested to perform an admittedly dangerous but essential task, and the threat to the health and safety programs would be under control. Thinking along these lines at NASA Headquarters has led us to propose the following procedure when a request for hazard pay is made:

(1) Find out what safeguards have been provided.

(2) Determine whether these safeguards are adequate.

(3) If they are adjudged adequate, no pay differential is authorized.

(4) If they are adjudged inadequate, determine what additional safeguards are necessary for adequate protection.

(5) Determine whether the provision of these additional safeguards is practicable.

(C) If the new safeguards are considered practicable, they must be provided. Again, no pay differential is authorized.

(D) If the safeguards are not practicable, a top-level management decision must be made as to whether performance of the hazardous task is to be undertaken. (This decision must be based on the considerations of employee protection and the essentiality of the task. The question of a pay differential is not to be considered.)

(E) If the decision is to go ahead with the task, the pay differential is authorized.

According to this procedure, hazard pay could be authorized only for tasks considered by top-level management to be essential despite admitted danger that, for all practical purposes, can not be adequately safeguarded. This procedure requires four decisions before dangerous assignments can be initiated:

(1) Are the existing safeguards adequate? This decision should be made by safety or environmental health specialists.

(2) What additional safeguards are necessary? This decision should also be made by safety or environmental health specialists.

(3) Are the necessary safeguards practicable? This decision should be made by project or operations management personnel.

(4) Is the performance of the dangerous task to be permitted? This decision should be made by the highest level of management at the installation.

This decision-making process is a very commendable one whether hazard pay is a problem or not. However, it should be noted that the decisions must be taken before hazard pay can be authorized. When hazard pay is imposed, the procedure should ensure that pay is never substituted for safeguards, that dangerous tasks are not undertaken unless they are essential, and that premium pay is prohibited for work deliberately performed under hazardous conditions for purposes of personal gain.

With all of these deliberations before us, we are prepared to look again at our Lancelot-hazard pay analogy. Our health and safety programs are at risk, as has been shown, and we must devise for them an effective protective mechanism, or chastity belt.

Several of us have been working on this problem for months at NASA Headquarters — the Office of Personnel, the NASA Safety Office, and the Division of Occupational Medicine and Environmental Health. We believe we have an answer. All pay is administered by Personnel. Our thought is to place a constraint on Personnel which would require that a judgement on the adequacy of safeguards be obtained from on-site health and safety specialists before hazard pay could be authorized. The request for this judgement would initiate the management decision-making process described earlier. This process would not involve the consideration of pay but would focus instead on a safeguards evaluation and on the question of whether a task that can not be practicably safeguarded should be performed at all. The final decision would be made by the highest level of management and forwarded to Personnel. It is a simple solution to a complex problem, but simple solutions are usually best.

N73-17096

ALLEGED MERCURY DISCHARGE BY THE LEWIS RESEARCH CENTER

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ALLEGED MERCURY DISCHARGE BY THE LEWIS RESEARCH CENTER

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INTRODUCTION

Since March 1966, NASA-Lewis has maintained continued communications with the Federal Activities Coordinator of the FWQA, Chicago Regional Office, including site visits, water sample analyses and regular effluent reports to the FWQA. Early in 1970 the FWQA became active in attempting to identify sources contributing to mercury pollution of the Great Lakes. The following chronology traces the impact of this investigation on the LeRC.

CHRONOLOGY OF THE ALLEGATION

April 13, 1970 - Mr. George Harlow, Director, Lake Erie Basin Office, FWPCA requested data on the usage of mercury at LeRC. A copy of current Mercury Inventory Records forwarded to Mr. Harlow indicated about a 290 lb loss out of approximately 5000 lbs in use and a total inventory of 25,000 lbs.

May 7, 1970 - Samples were taken by FWQA of industrial waste basin and storm sewers that receive basin discharge.

May 13 and 17, 1970 - Samples were taken by both FWQA and LeRC of industrial waste basin and storm sewer. All samples indicated < 2 ppb (parts per billion) mercury, i.e., below the limit of detection of the analytical method used.

June 4, 1970 - During the Lake Erie Enforcement Conference in Detroit the FWQA reported that "on May 7, 1970 a concentration of 11 ppb mercury was present in the outfall from the NASA, LeRC, Cleveland, Ohio."

July 20-21, 1970 - Samples of the Industrial Waste Basin effluent were taken by FWQA. The results are shown in Table I.

September 17, 1970 - Interior Secretary, Walter J. Hickel, released list of 50 industrial mercury polluters. Included on this list was NASA-Lewis.

REVIEW OF THE EVIDENCE

It would be well to stop at this point and review the evidence for mercury pollution by LeRC.

1. Mercury loss on Mercury Inventory Records: A perusal of the records over several years time indicates that the "loss" mercury is often simply overlooked mercury stock which is "found" at the next inventory. Therefore these records do not provide an unequivocal guide to that mercury which may be lost to the atmosphere or the sewer system.

2. The May 7 sample which showed 11 ppb was a single sample. Given the inexperience of the people who made the analysis and the problems of inadvertent contamination inherent in analysis of trace elements, one should not place too much confidence in the accuracy of this result.

3. In the case of all the analyses there was no determination made of a material balance. Or put another way, all mercury source

contributions to the outfall effluent were not ascertained. Such sources are: 1) airborne; 2) on site research activities; 3) maintenance activities, e.g., pesticide applications; and 4) water entering the LeRC, i.e., Cleveland tap water.

THE FOLLOW-ON INVESTIGATION

To determine more exactly the source and actual amount of mercury contamination a further set of water samples were taken by LeRC on Sept. 23, 1970 and analyzed, using the neutron activation analysis (NAA), by the U.S. Geological Survey Laboratory in Denver, Colorado. The results given in Table II were presented at a meeting, Oct. 7, 1970 called by the Office of Director of Enforcement, FWQA, Chicago. It is evident from the results that within the limits of precision of the reported there is no difference between incoming tap water and outgoing industrial/storm sewer water. The internal standard, distilled water spiked with 1.0 ppb mercury, gives a measure of the accuracy of the analytical technique. The accuracy of the method is good, as indicated by the exact agreement between the analytic result and the internal standard.

Follow-on tests were performed by FWQA and NASA-Lewis on October 12-13, 1970. The results are shown in Table III. Analyses were performed at FWQA facilities in Cincinnati, Ohio and at LeRC using the flameless atomic absorption (FAA) procedure (Provisional FWQA Method for Mercury Analysis, Sept., 1970). All results indicated mercury concentrations below the limits of detection.

THE ACCUSATION LINGERS

November 30, 1970 - A letter from Col. Hansen, Corps of Engineers, Buffalo District to LeRC read in part, "It has come to my attention that you are discharging mercury or effluent containing mercury into the waters of the Rocky River.... Section 13 of the Rivers and Harbors Act of 1899 makes it unlawful to discharge or deposit matter of any kind or description into any navigable water or tributary thereof in the absence of a Department of Army Permit."

April 1971 - Dow Chemical of Canada, facing a suit by the State of Ohio for alleged mercury pollution, issued a press release published in the news media which carried allegations that LeRC is polluting Lake Erie with mercury — based on the June 3, 1970 Lake Erie Conference Report.

DENOUEMENT

On July 26, 1971 the following letter addressed to the Director, NASA-Lewis Research Center was sent by Wm. D. Ruckelshaus, Administrator, EPA.

> This is in reply to your letter of April 9, 1971, concerning the discharge of mercury at Lewis Research Center.
>
> Dr. Francis T. Mayo, Acting Regional Administrator, Region V, Environmental Protection Agency has responded to your identical letter to him with regard to our initial findings of mercury in the effluent from NASA's Lewis Research Center. We agree that on the basis of later analyses we do not detect the addition of mercury by those facilities in the effluent.

Our reports since December 1970 have listed the NASA Lewis Research Center as not discharging mercury. This information has been provided to Congressional committees that have followed closely our activities in the mercury situation and to the press. Please be assured that any press release issued by EPA and dealing with known mercury dischargers will reflect the fact that we do not find these facilities to be discharging mercury.

A SIDELIGHT

Since September 1970 the LeRC has run mercury analysis on City of Cleveland tap water on site. We find that the mercury content of the water effluent follows closely the mercury content of the water entering the Center. Figure 1 gives the mercury concentration of the tap water over the period September 1970 to August 1971. The data indicated by the solid circles were obtained by the FAA method and the single data in point indicated by the solid triangle was obtained by the NAA method. The data ranges from 0.1 ppb, which corresponds to the predicted background level for Lake Erie, to 0.5 ppb or possibly 1.8 ppb. The fluctuation over the year period appears to be relatively large. The true range of the fluctuation and whether the fluctuation is seasonal - due to shifting or disturbance of lake silt near the water system intake or due to another cause - can only be determined by further investigation.

CONCLUDING REMARKS

In retrospect the mercury discharge allegation has increased our awareness of the pollution potential of our research and technology

operation and reemphasized the need for tight operational control. In the process of investigating the charges we developed new analytical capacility and expertise and also uncovered an unanticipated tap water situation.

MERCURY ANALYSIS RESULTS
JULY 20-21, 1970

SAMPLING LOCATION	EST. FLOW MGD*	MERCURY PPB**	MERCURY LBS/DAY
INDUSTRIAL WASTE BASIN OUTFALL INTO STORM SEWER (24 HOURS COMPOSITES)	1.1	2.8	0.03

* MILLIONS OF GALLONS PER DAY.

** PARTS PER BILLION.

TABLE I

USGS ANALYTICAL RESULTS
SEPT. 28, 1970

SAMPLING LOCATION	MERCURY PPB
INTERNAL STANDARD (DISTILLED WATER CONTAINING 1.0 PPB MERCURY)	1.0 ± 15%
INDUSTRIAL WASTE BASIN OUTFALL (COMBINED WITH STORM SEWER)	2.0 ± 15%
INDUSTRIAL WASTE BASIN NO. 1	1.3 ± 15%
INDUSTRIAL WASTE BASIN NO. 2	1.9 ± 15%
SANITARY SEWER	0.7 ± 15%
CITY OF CLEVELAND TAP WATER (ON SITE, NASA)	1.8 ± 15%

TABLE II

MERCURY ANALYSIS RESULTS
OCT. 12 - 13, 1970

SAMPLING LOCATION	MERCURY, PPB FWQA	NASA
CITY OF CLEVELAND TAP WATER (12 IN. AND 24 IN. WATER SUPPLY PIPES)	< 1.0	< 0.5
INDUSTRIAL WASTE BASIN OUTFALL (COMBINED WITH STORM SEWER)	< 1.0	< 0.5
INDUSTRIAL WASTE BASIN NO. 1	< 1.0	< 0.5
SANITARY SEWER	< 1.0	< 0.5

TABLE III

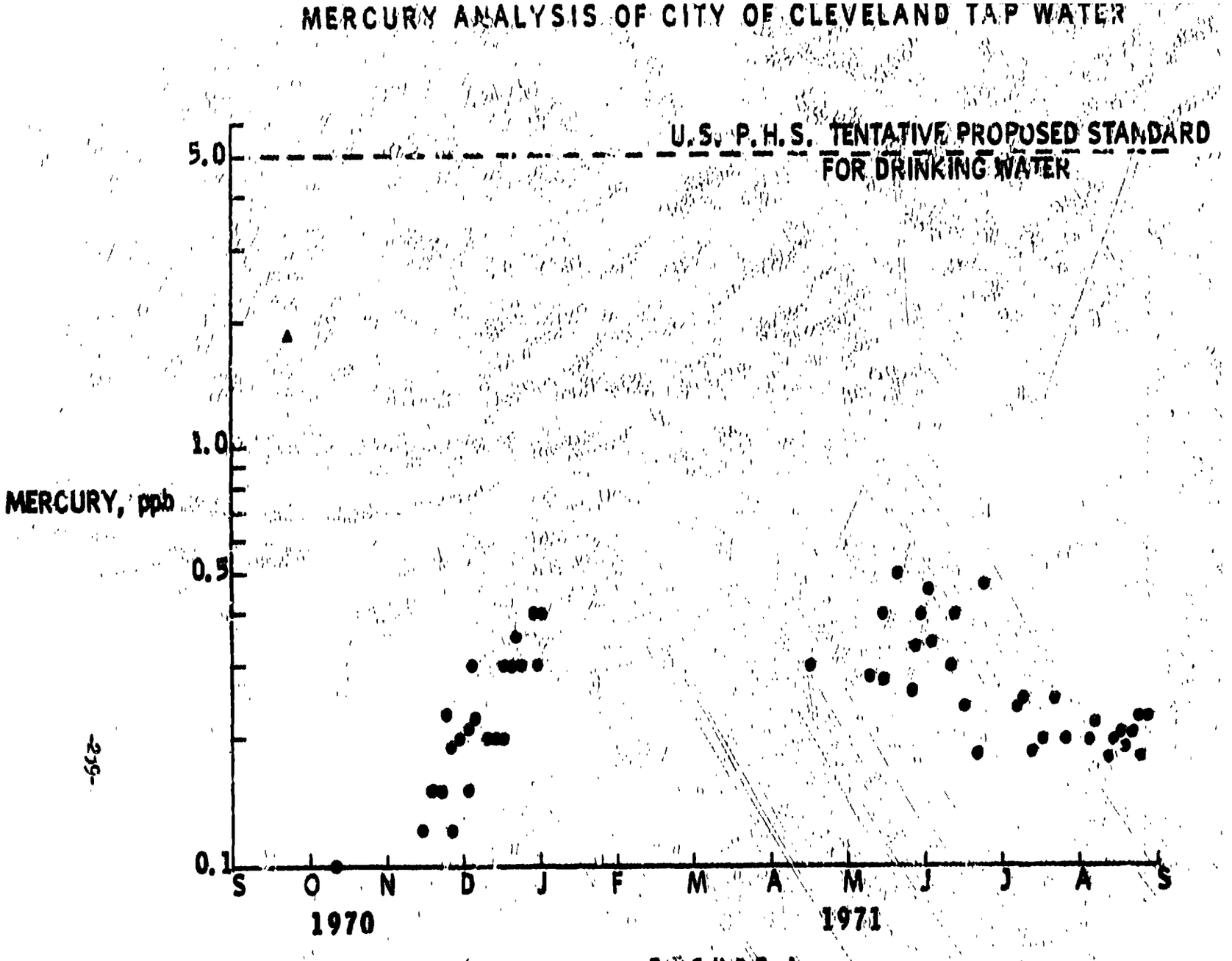
MERCURY ANALYSIS OF CITY OF CLEVELAND TAP WATER
U.S. P.H.S. TENTATIVE PROPOSED STANDARD FOR DRINKING WATER
5.0
1.0
0.5
0.1
MERCURY, ppb
S O N D J F M A M J J A S
1970
1971

FIGURE 1

LEAD PENCILS

Leven B. Gray
Chief, Health & Safety Engineering Office
Goddard Space Flight Center

YOU CAN LEAD A HORSE TO WATER BUT A PENCIL HAS TO BE LEAD

The purpose of this brief presentation is to share with you some information gained from a study performed at Goddard concerning the lead content of the paint on various pencils in our supply system.

It was brought to our attention that pencils found in the Washington, D. C. area contained lead in their paint. We were told that during a drive to eliminate rats from some of the ghetto areas, pencils were provided as an incentive to children to participate in the campaign which was called "The War on Rats". Ironically, these pencils which were yellow and had printing on them which said "Get the Lead Out-Fight the War on Rats" have something like 23 mg. lead content in their paint. Fortunately, they were not distributed. Armed with this information several of the pencils in one of our laboratory areas were examined and indeed found to have lead contained in their paint also. We requested an analysis of each of the different pencils in our local Center stock and the results are presented in Table I. The method used was X-ray secondary fluorescence analysis. The detection limit for this method was stated to be .0005 mg/cm^2.

The results of the survey were reported in milligrams of lead in the paint of the entire pencil and as milligrams of lead per square centimeter. The amount of lead found varied from .04 milligrams (mg) per pencil for a carmine colored pencil (No. 25 in Table I) to approximately 43 mg. per pencil for a yellow colored pencil (No. 35 in Table I). In general, pencils painted yellow seemed to have higher lead content than other colors.

In an effort to determine just how significant the hazard might be we ran an item in our local announcement bulletin which informed the personnel of the potential problem in a low key way and solicited people who were concerned or regarded themselves as chronic pencil chewers to contact our Health Unit. The physicians, after evaluating the situation, might determine whether or not a correlation existed between chewing the pencil and biological analysis for lead. Unfortunately, only one person reported and no analyses were performed. In addition, our supply people and the GSA supply personnel were advised of the situation and requested to revise their specifications prohibiting pencils with paint with detectable lead content from being procured in the future. Since the study showed that pencils with the

same color were available with no detectable lead content, this was not expected to be a problem.

It is our understanding that the Pencil Maker's Association, Inc. of Wayne, Pennsylvania have pledged a similar change to their manufacturing specifications to bring them in line with the Food and Drug Administration's limit of less that 1% lead content for paint on toys.

TABLE I

	MODEL	MANUFACTURER	LEAD COLOR	PAINT COLOR	Pb (mg./PENCIL)	Pb(mg/cm²)
1.	KOH-I-NORR "Offset" No. 656	L&C Hardmuth, Inc.	Black	Yellow	0.84	0.00151
2.	Ravenwood Bonded Lead 1080, No. 1	Reliance	Black	Yellow	13.93	0.390
3.	Ravenwood Bonded Lead 1080, No. 2	Reliance	Black	Yellow	20.12	0.563
4.	Forum 739 No. 3	Venus	Black	Yellow	15.16	0.447
5.	Templar 742	Reliance	Black	Black	*	*
6.	No 2-2/4	Wallace Pencil Company	Black	Gray	*	*
7.	Unique 1237	Venus	Carmine Red	Red	*	*
8.	Test Scoring 100	Musgrave Pencil Co., Inc. Shelbyville,TN	Black	Silver	*	*
9.	Beginners-308 (Jam Large Dia)	Dixon	Black	Black	*	*
10.	Arlington No. 2	Arlington	Black	Yellow	12.78	0.388
11.	Arlington No. 3	Arlington	Black	Yellow	21.02	0.589
12.	KOH-I-NORR, Polycolor 16, No. 1	L&C Hardmuth, Inc.	Green	Green		
13.	No. 3	Musgrave Pencil Company	Black	Yellow	21.69	0.608
14.	Vita-Color 1820 Yellow	Linton (USA)	Yellow	Yellow	0.24	0.01468
15.	Magnolia 2372	Reliance	White	White	*	*
16.	General's Red & Blud Crayon 1201	General	Blue	Blue	4.06	** 0.01136
			Red	Red	4.89	0.01370
17.	KOH-I-NOOR Flexicolor Green 1800,16	L&C Hardmuch, Inc.	Green	Green	*	*
18.	Templar Drawing 778, 2R	Reliance	Blue	Black	*	*
19.	Mephisto Brow ,for checking blue-prints	L&C Hardmuth, Inc.	Brown	Brown	*	*
20.	Unique	Venus	Blue	Blue	*	*
21.	Professional Drawing 1000, 4H	L&C Hardmuth, Inc.	Blue	Black	*	*
22.	Custom L 900 5H	Linton	Blue	Black	*	*
23.	Formost 707T, 2-4/8	Reliance	Black	Yellow	16.2	0.450
24.	Polycolor KOH-I-NOOR 1600, No. 4	L&C Hardmuth, Inc.	Yellow	Yellow	*	*
25.	Polycolor KOH-I-NOOR 1600, No. 30	L&C Hardmuth, Inc.	Carmine	Carmine	.0448	.00035
26.	Polycolor KOH-I-NOOR 1600, No. 8	L&C Hardmuth, Inc.	Orange	Orange	*	*
27.	Polycolor KOH-I-NOOR 1600, No. 35	L&C Hardmuth, Inc.	Red	Red	4.630	0.1288
28.	Polycolor KOH-I-NOOR 1600, No. 1	L&C Hardmuth, Inc.	White	White	*	*
29.	Colorbrite 2122	Eberhard Faber	Orange	Orange	21.035	0.589
30.	Colorbrite 2127	Eberhard Faber	Yellow	Yellow	26.718	0.748
31.	Colorbrite 2111	Eberhard Faber	White-Chrome	White-Chrome	*	*
32.	Generals Insoluble Colortex 1613	General	Yellow	Yellow	28.777	0.750
33.	Best 324-1/2	Dixon	Ochre	Ochre	*	*
34.	Best 3520	Dixon	White	White	*	*

TABLE I (Continued)

MODEL	MANUFACTURER	LEAD COLOR	PAINT COLOR	Pb (mg./ PENCIL)	Pb (mg/cm²)
35. Test 3530	Dixon	Yellow	Yellow	42.832	1.20
36. Drawing 2H	Venus	Black	Green	*	*
37. Test Scoring 100	Musgrave Pencil Company	Black	Black	*	*
38. 2538	Addressograph-Multigraph Corp.	Blank	Red	20.789	0.583
39. Unique 1207 Red	Venus	Red	Red	*	*
40. Unique 1208 Green	Venus	Green	Green	17.468	0.489
41. Unique 1209 Yellow	Venus	Yellow	Yellow	*	*
42. Unique 1214 Orange	Venus	Orange	Orange	*	*
43. Unique 1217 Pink	Venus	Pink	Pink	*	*
44. Unique 1218 Light Green	Venus	Light Green	Light Green	*	*

* No detectable lead above limits for test conditions (0.0005 mg/cm^2)
** Blue half of pencil had blue over red paint

SURVEY OF HEAVY PARTICLES IN THERAPY

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and
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ABSTRACT

Paper presented at Annual meeting of Occupational Medicine and Environmental Health Directors, Consultants, and Advisors, Charleston, South Carolina, October 12 - 14, 1971.

A broad overview of basic radiobiological mechanisms and their relationship to radiotherapy was presented.

The application of heavy particles (i.e., protons, alpha particles, negative pions, neutrons, heavy ions) in the treatment of neoplastic disease was evaluated. Important physical parameters characterizing each type of particle were discussed in terms of their applicability to particular treatment situations.